

Motor Systems: Lecture 6

Integrated Motor Systems



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Grab bag

- Candy
 - West U Science Night
 - Brain tattoos
 - Basal Ganglia crowdsourcing
 - PVS
 - Robin Williams
- 
- Not on test
- Motor systems review

West University Elementary School Science Night

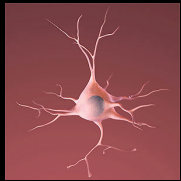
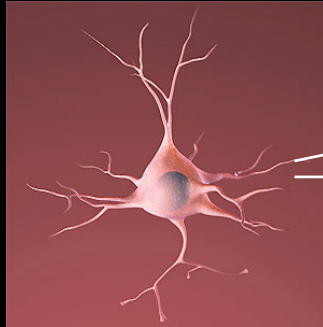
April 14th, 5:30 pm – 7:30 pm



West University Elementary School Science Night

April 14th, 5:30 pm – 7:30 pm

Brain tatoos



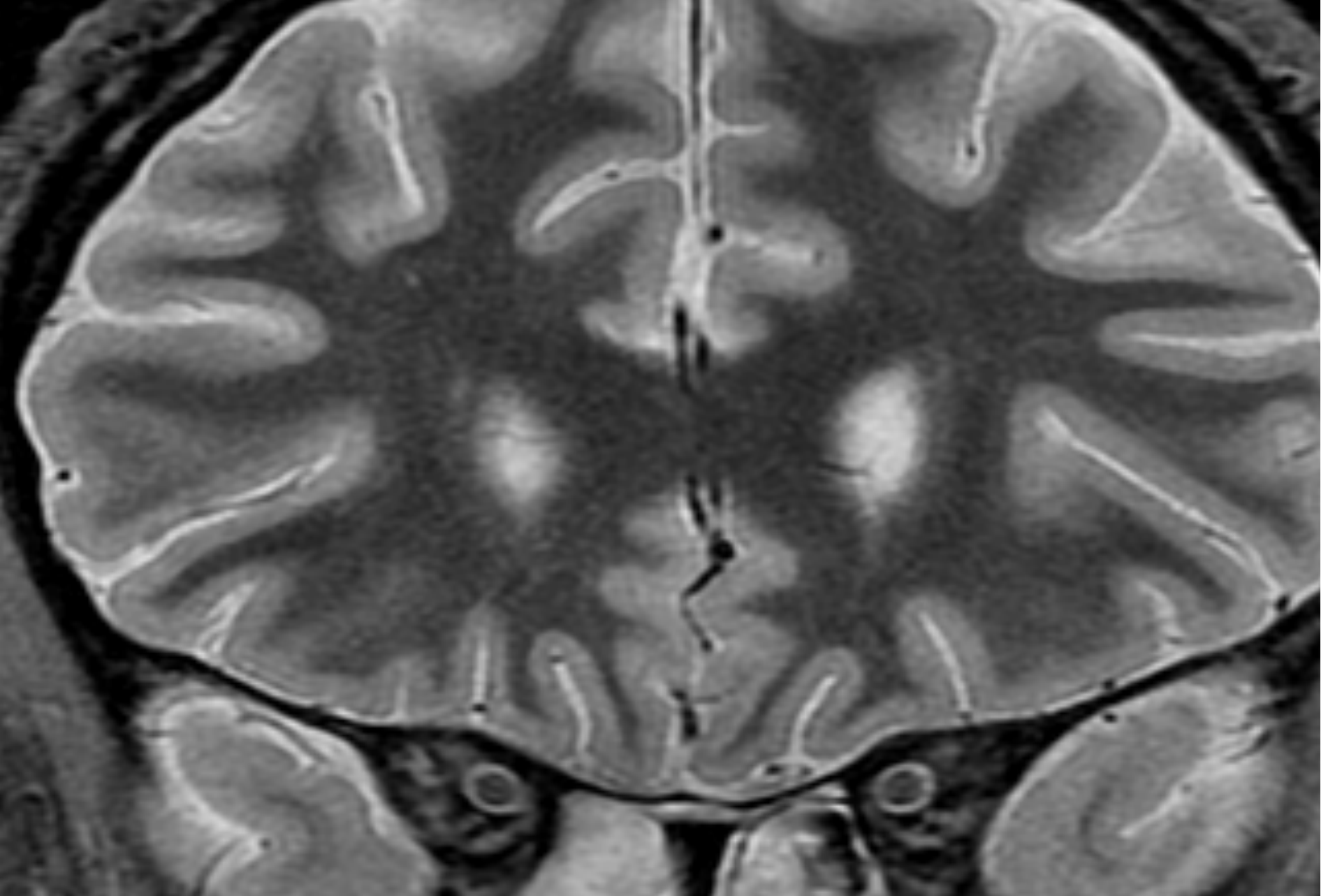
Brain tatoos

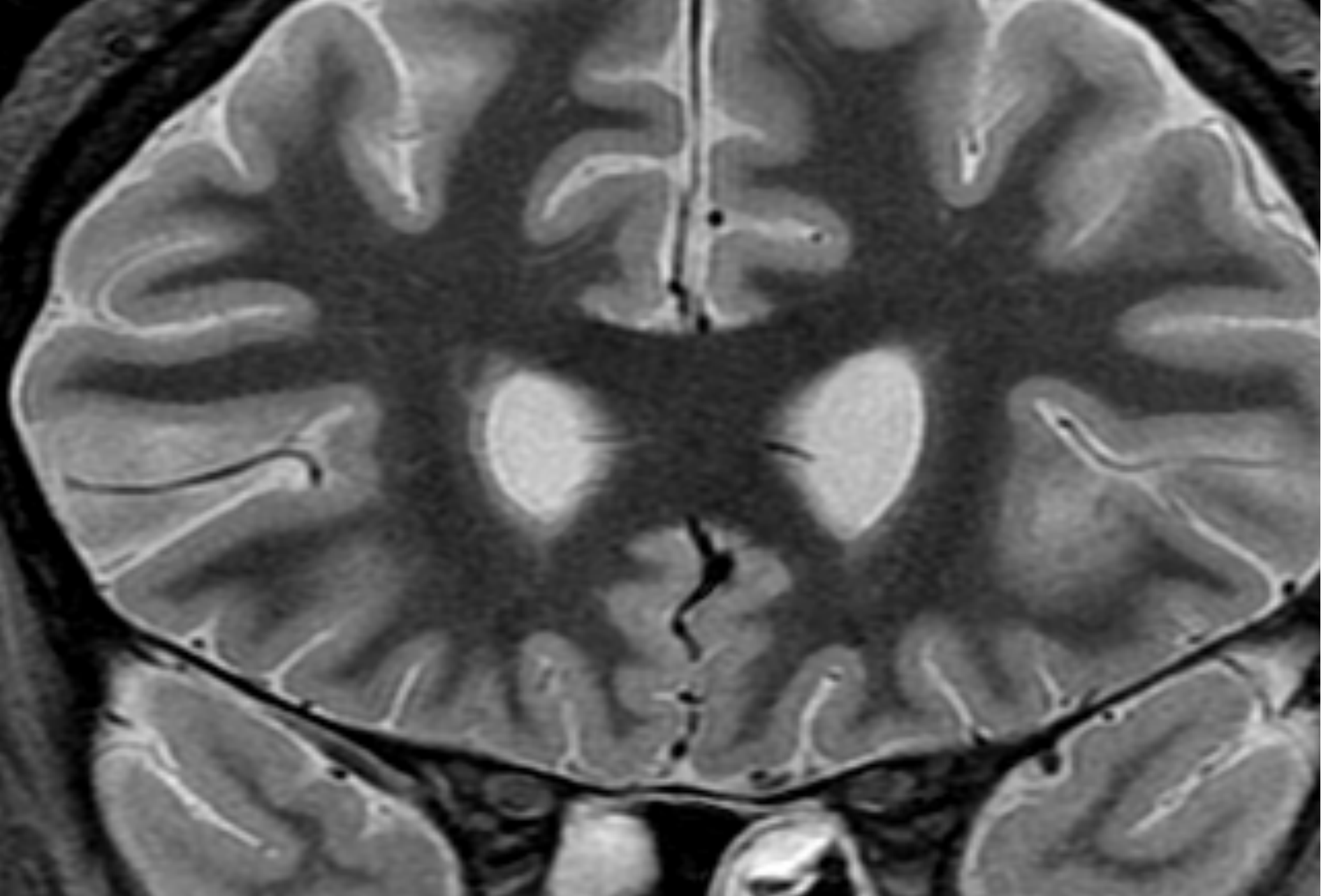


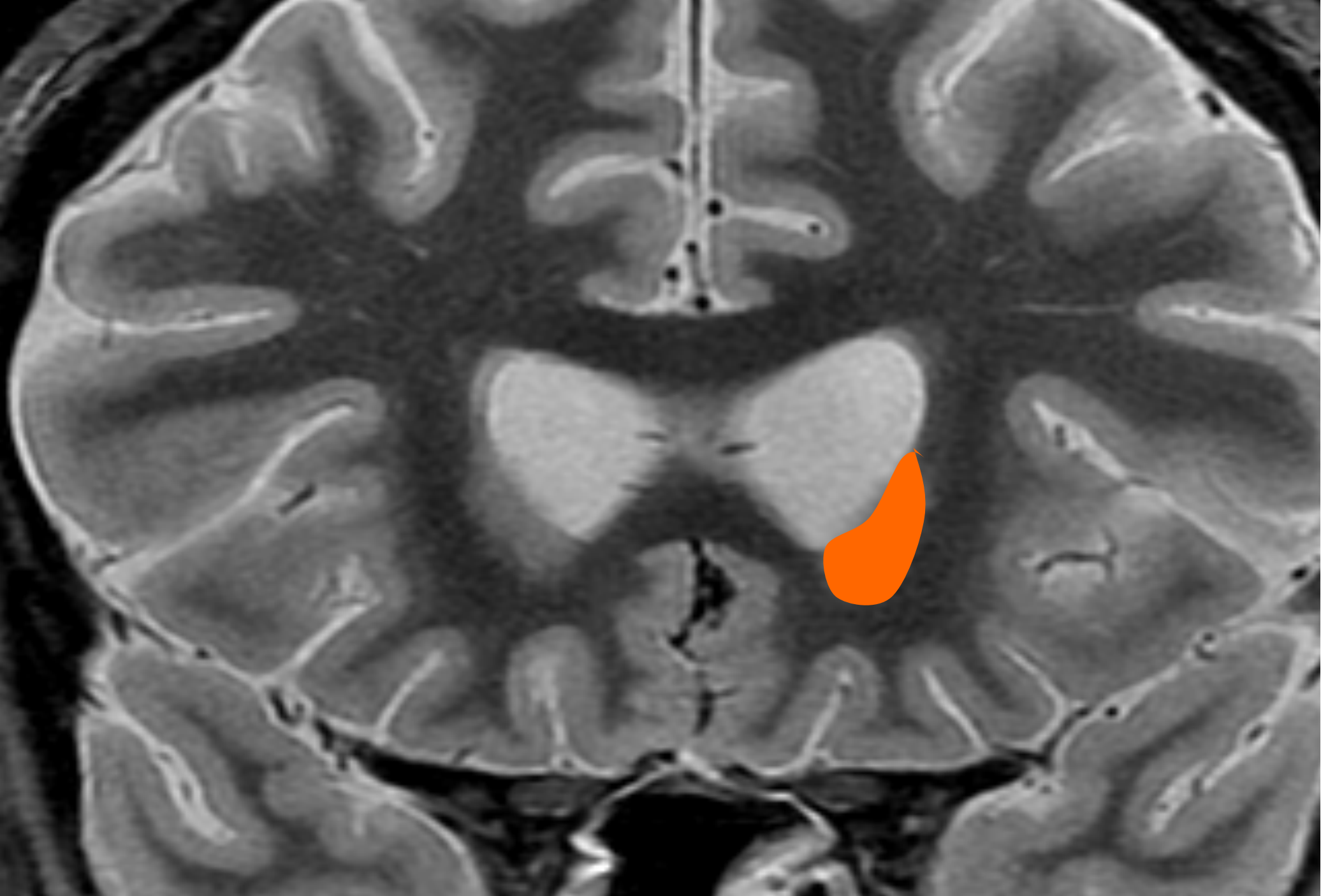
Thanks to Emma Dishner, Alicia Fuhrman

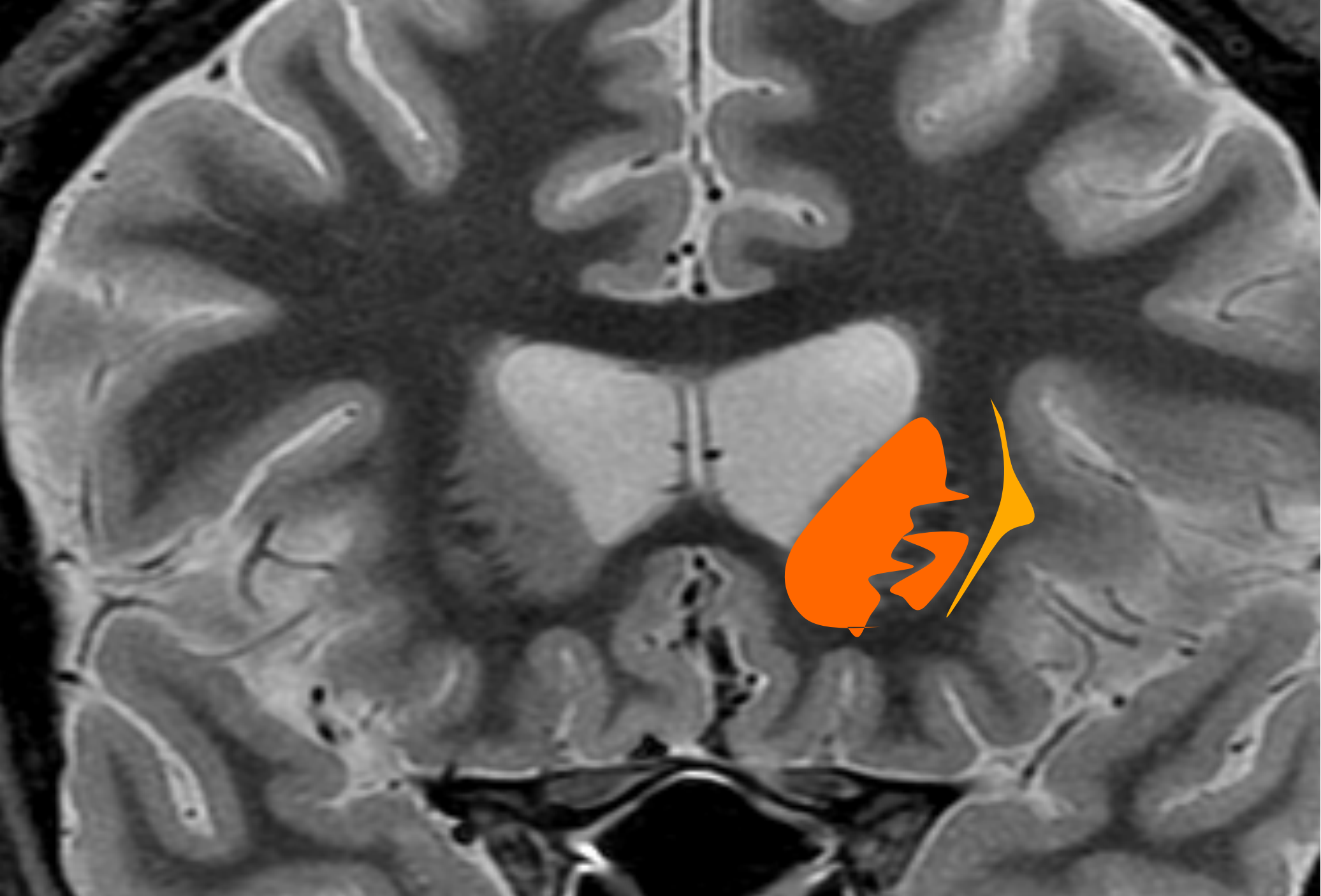
Basal Ganglia Crowdsourcing

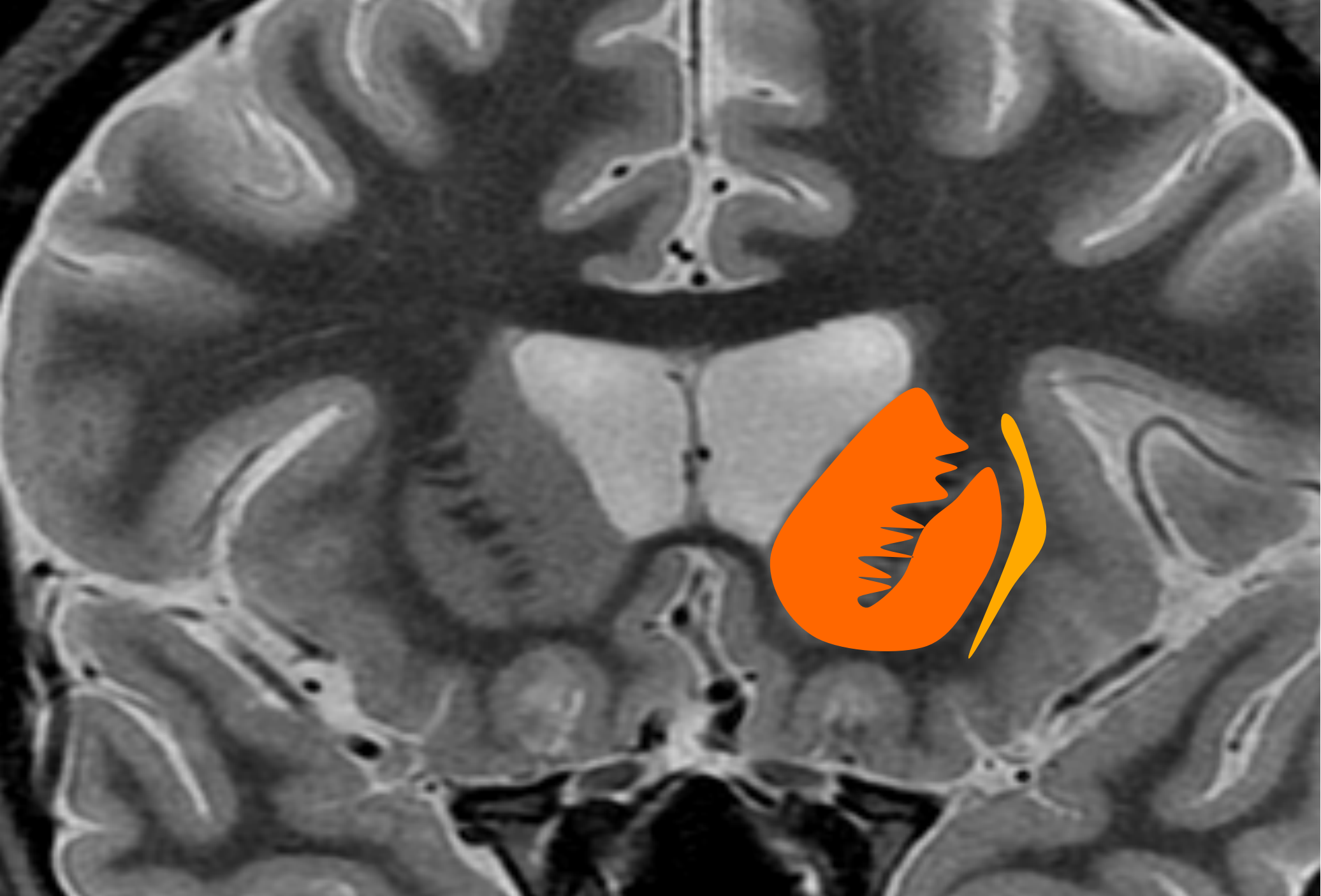
- Steven G. Ojemann (neurosurgeon, University of Colorado)
- Openwetware.org/wiki/Beauchamp

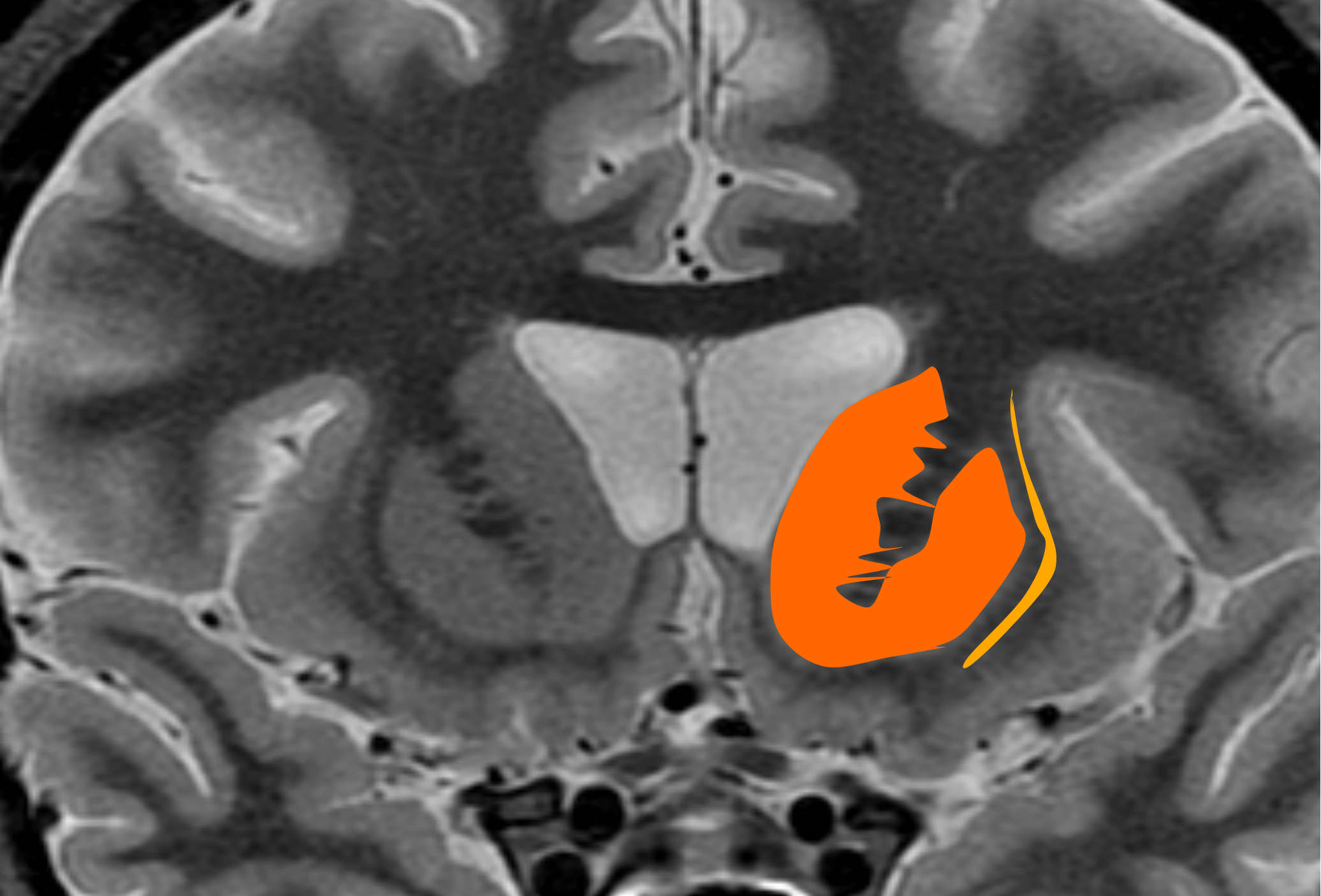


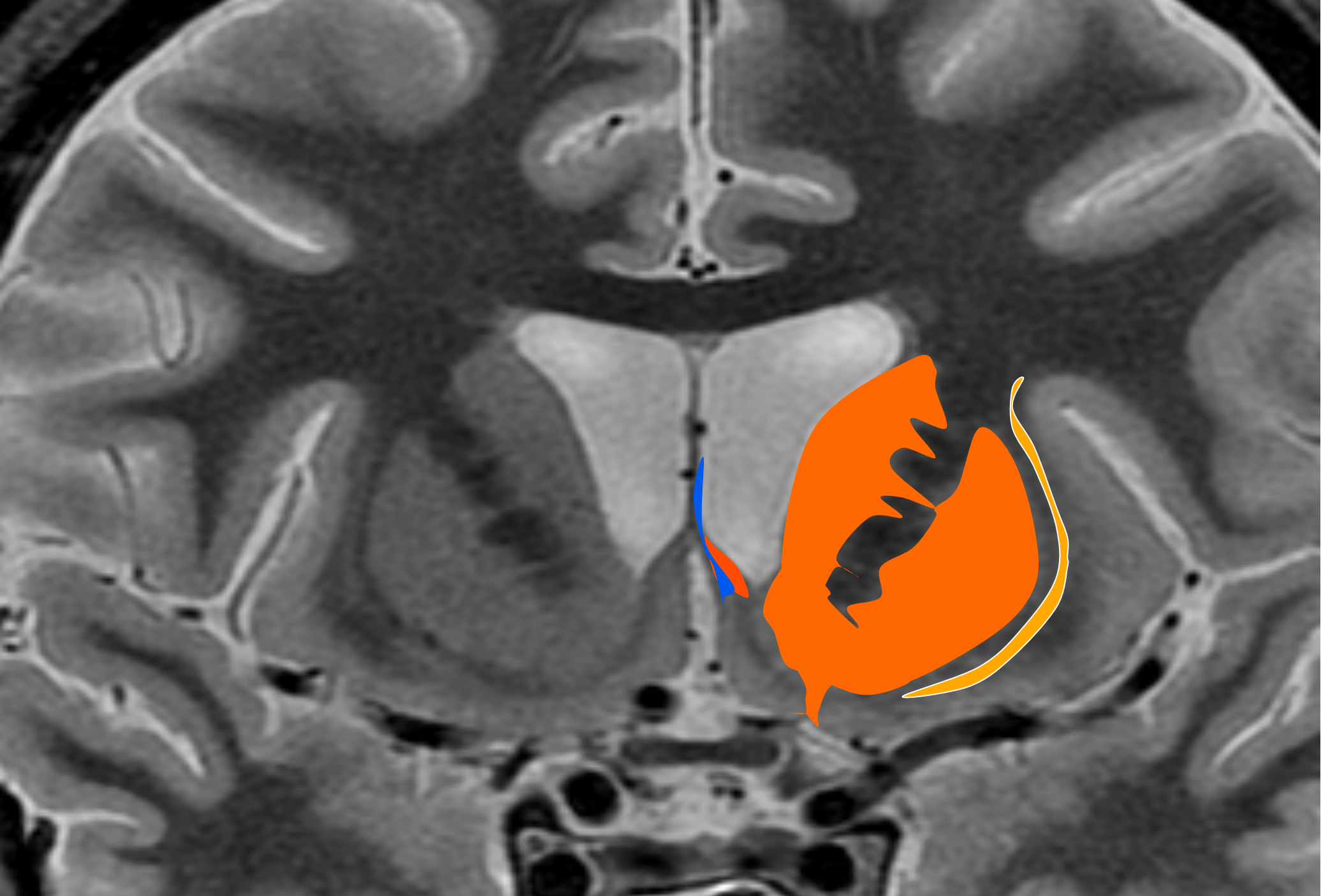


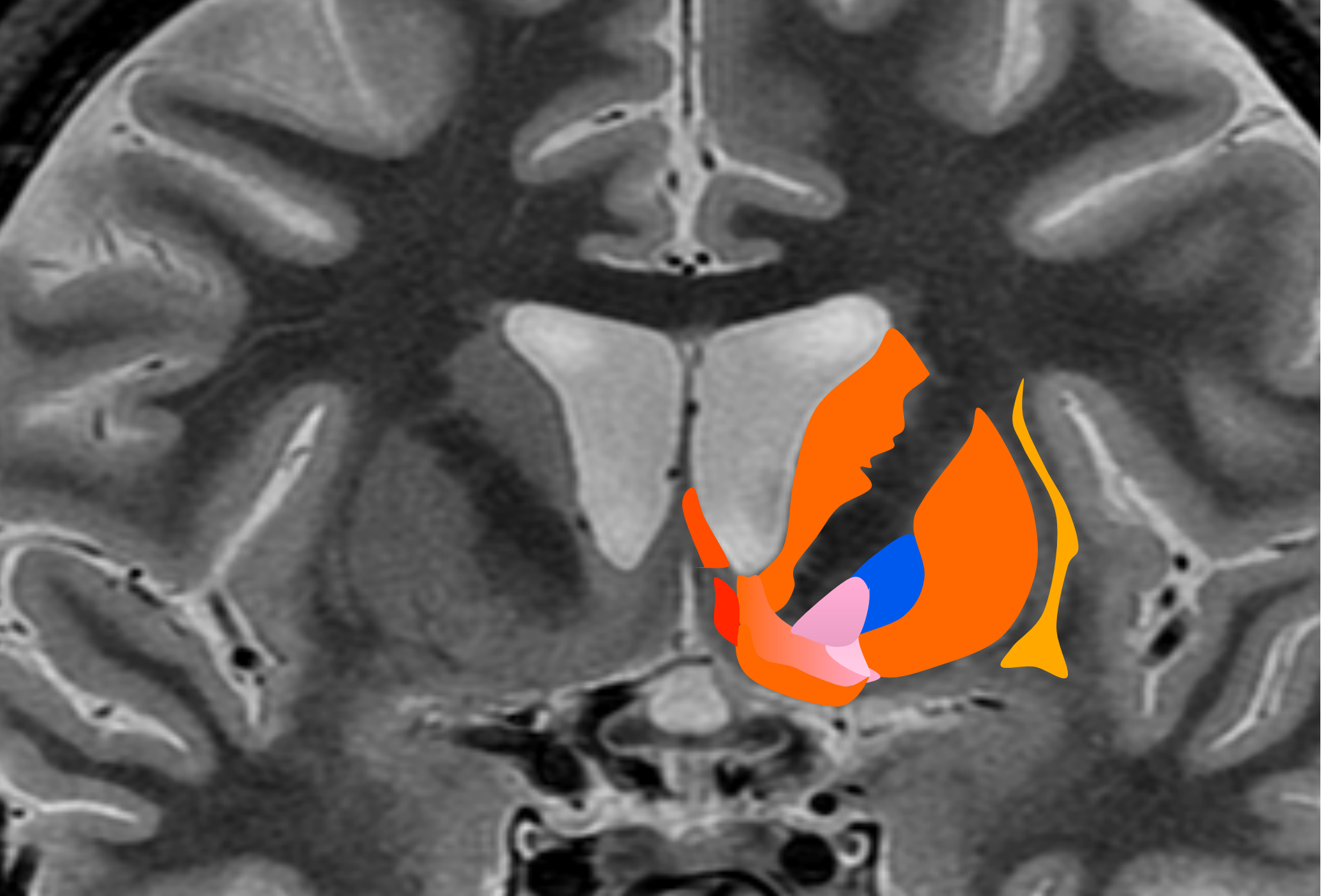


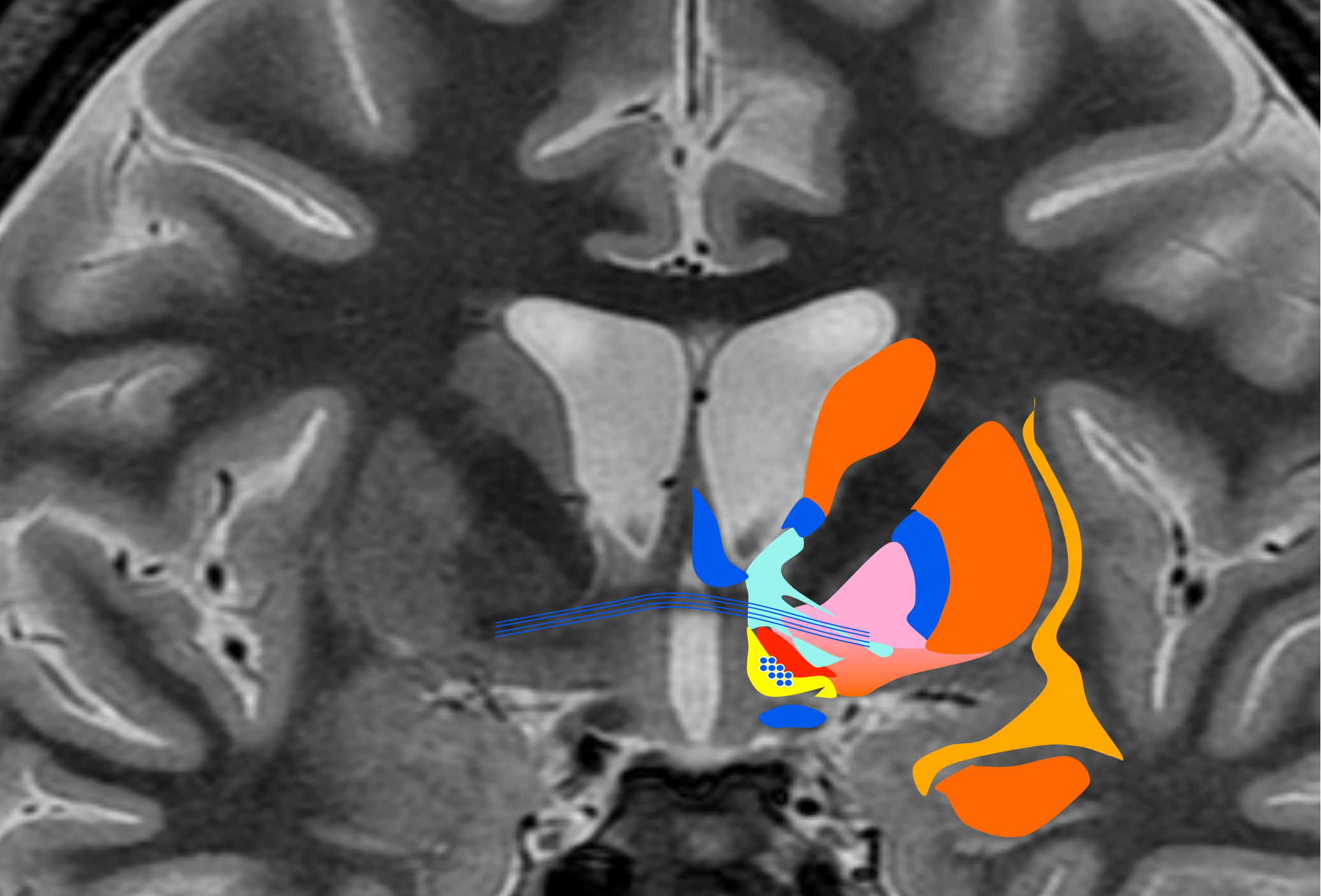


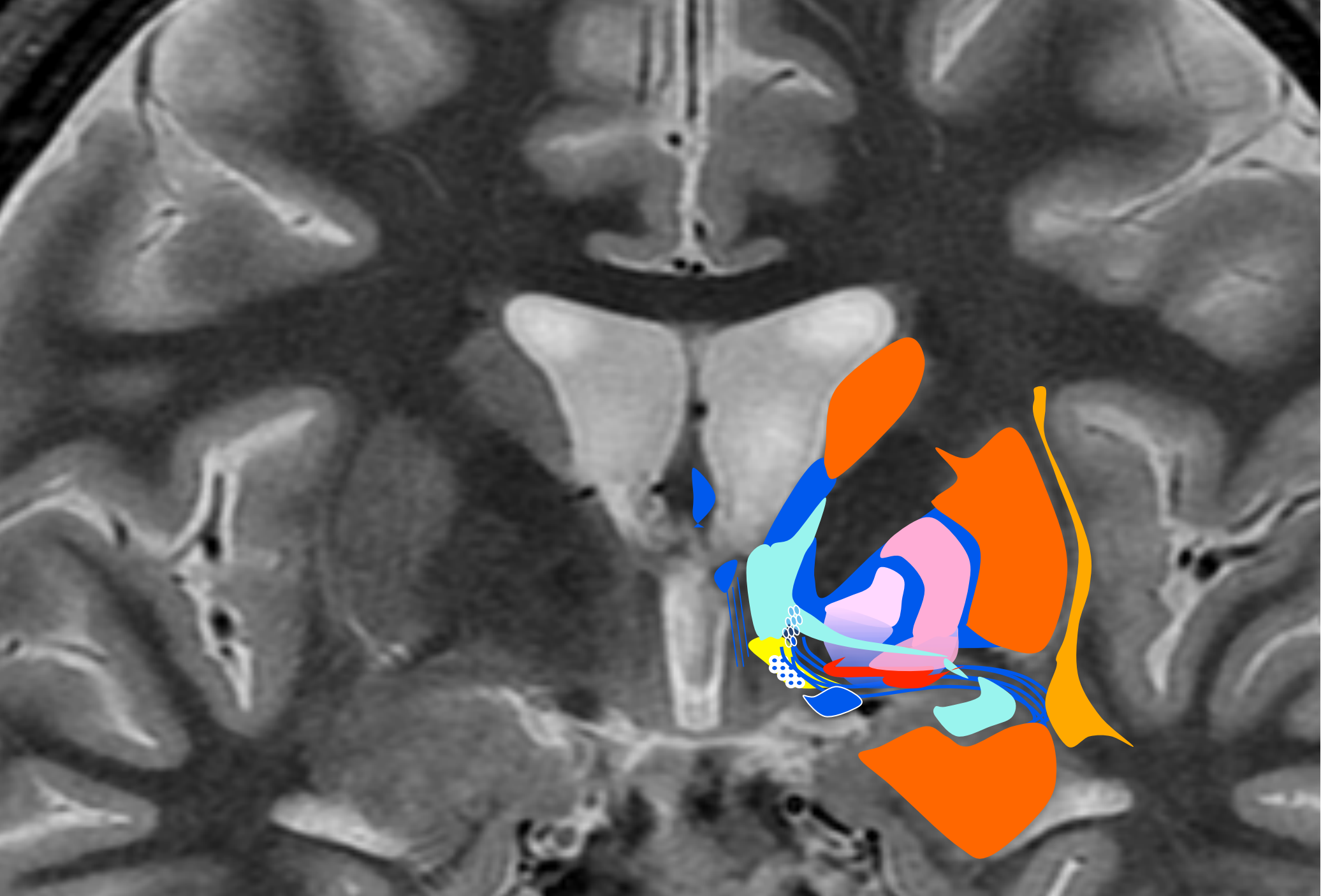


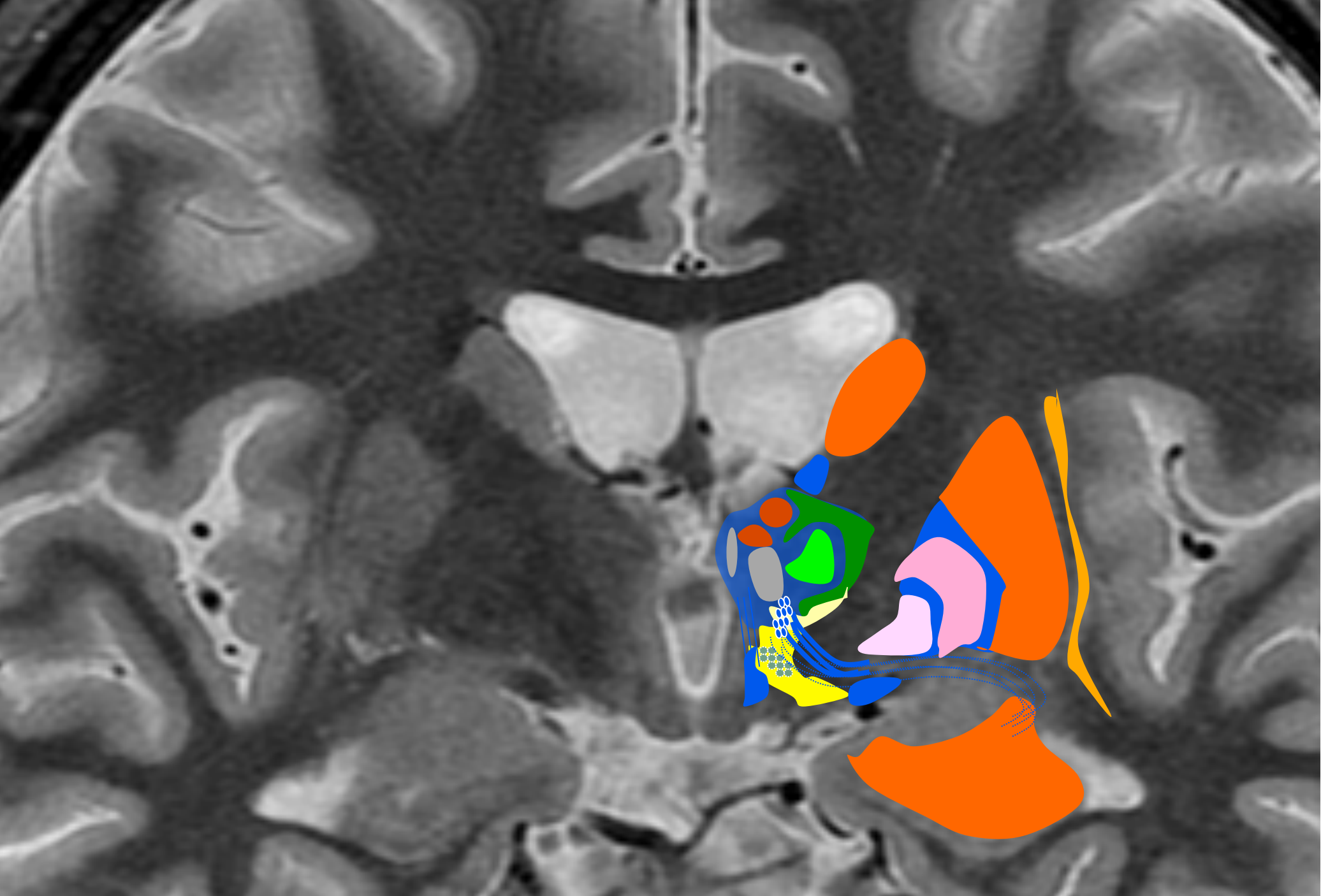


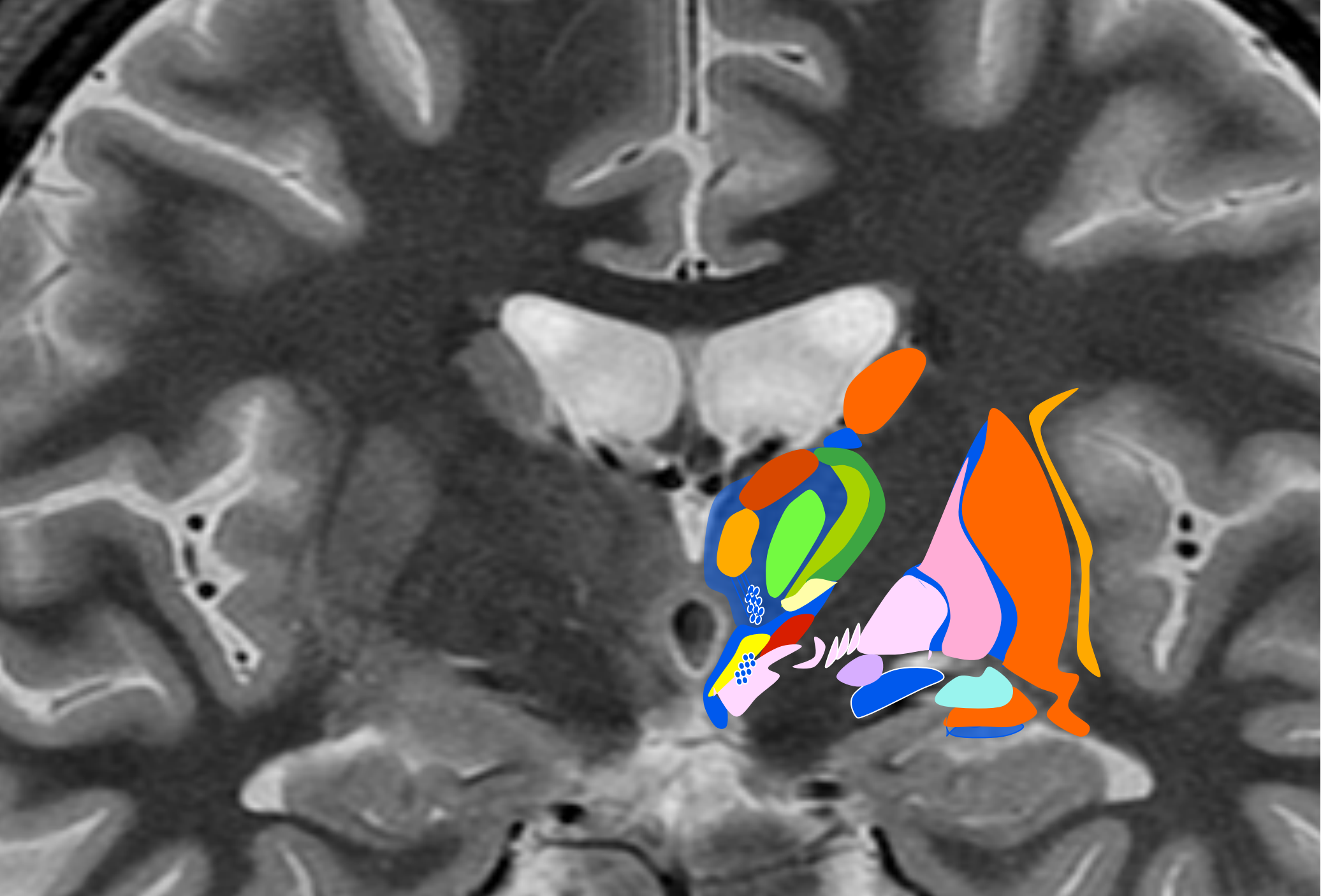


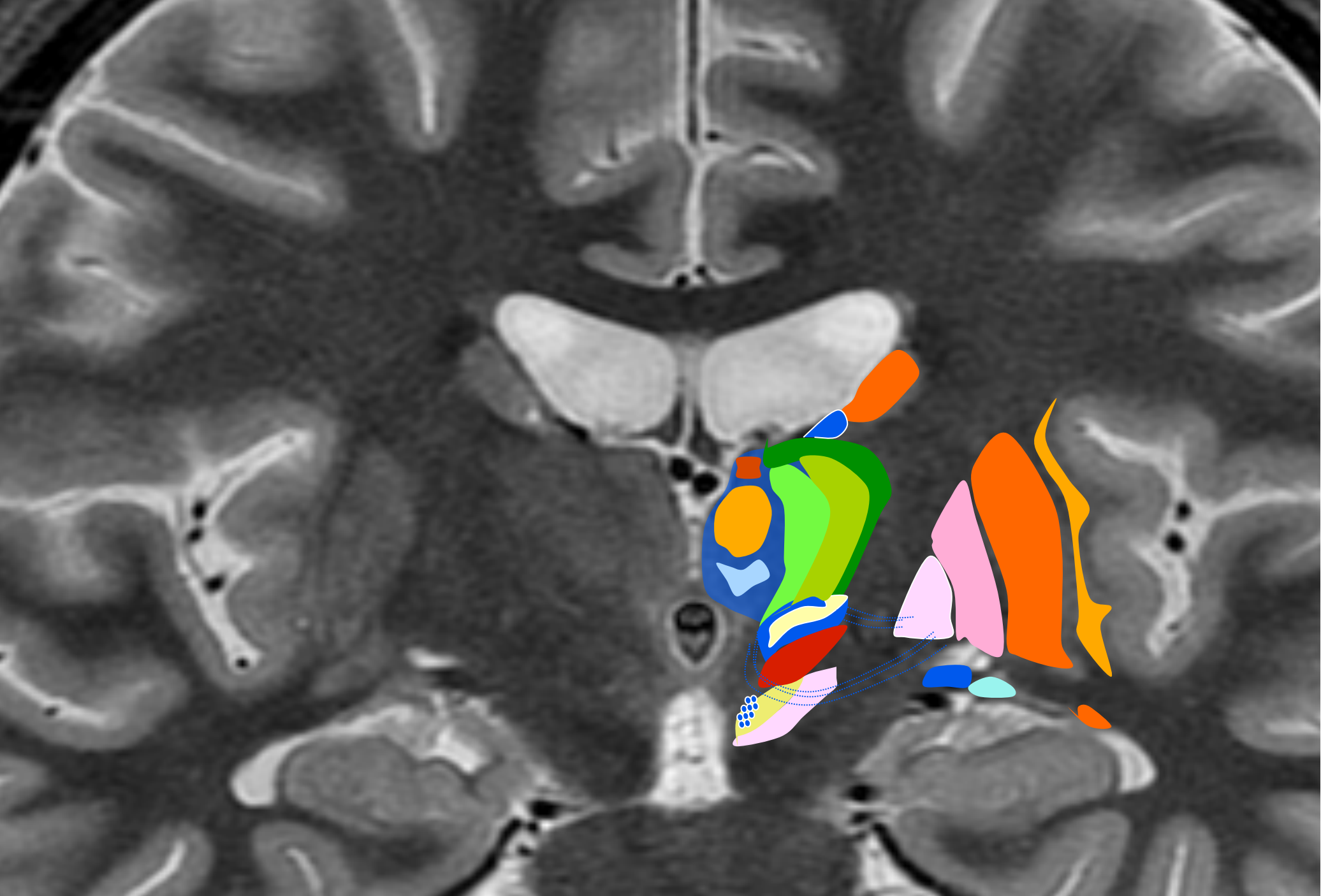


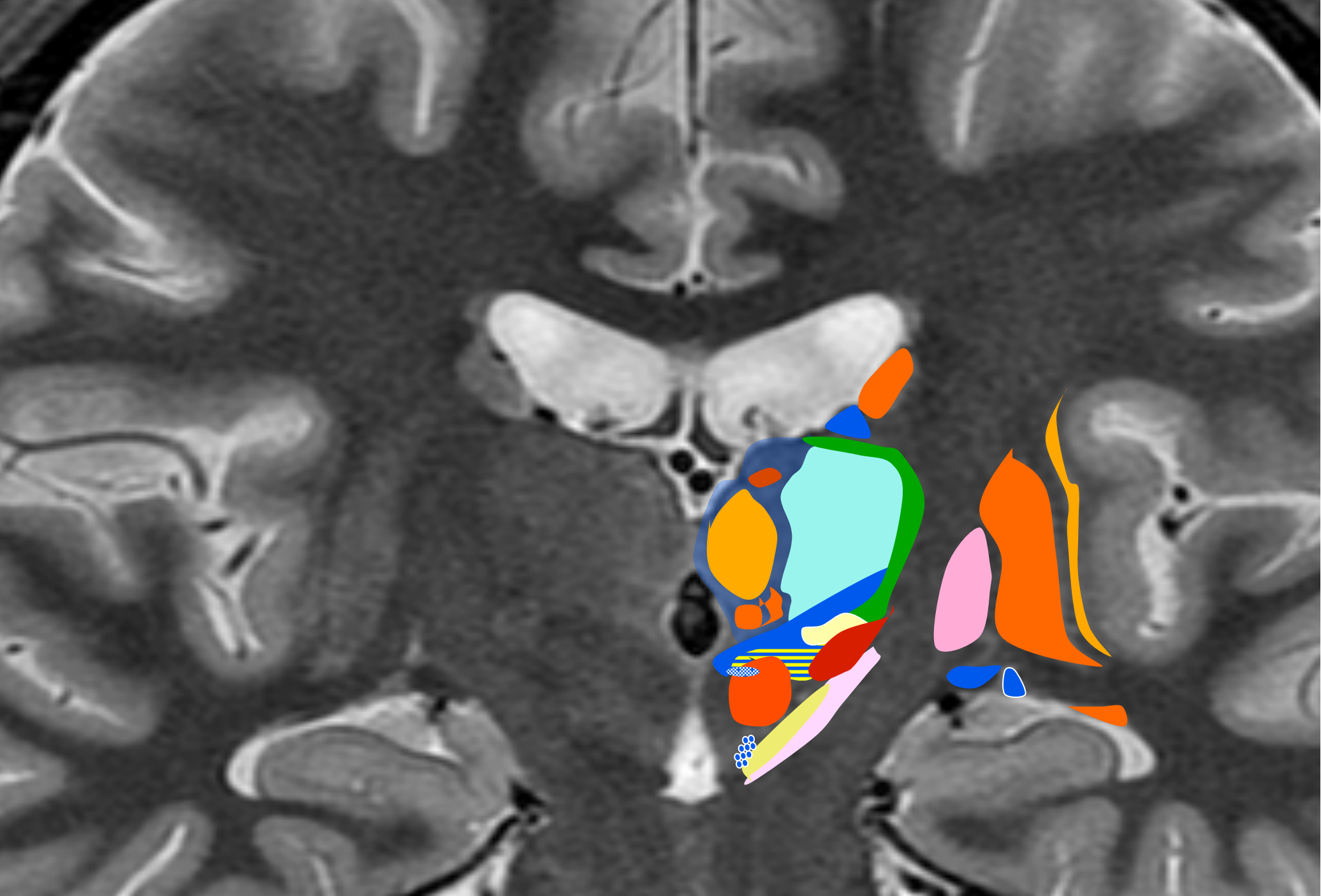


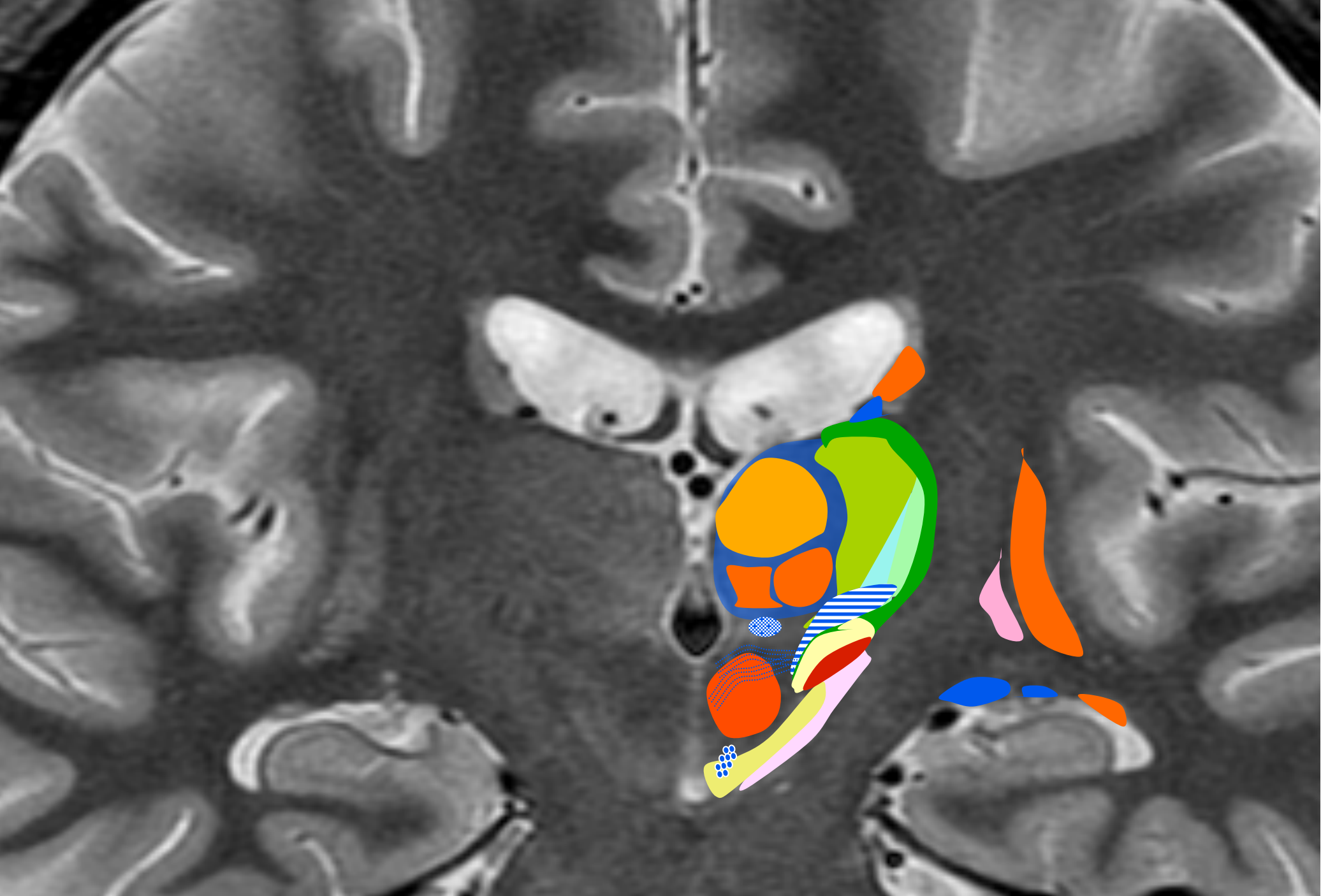


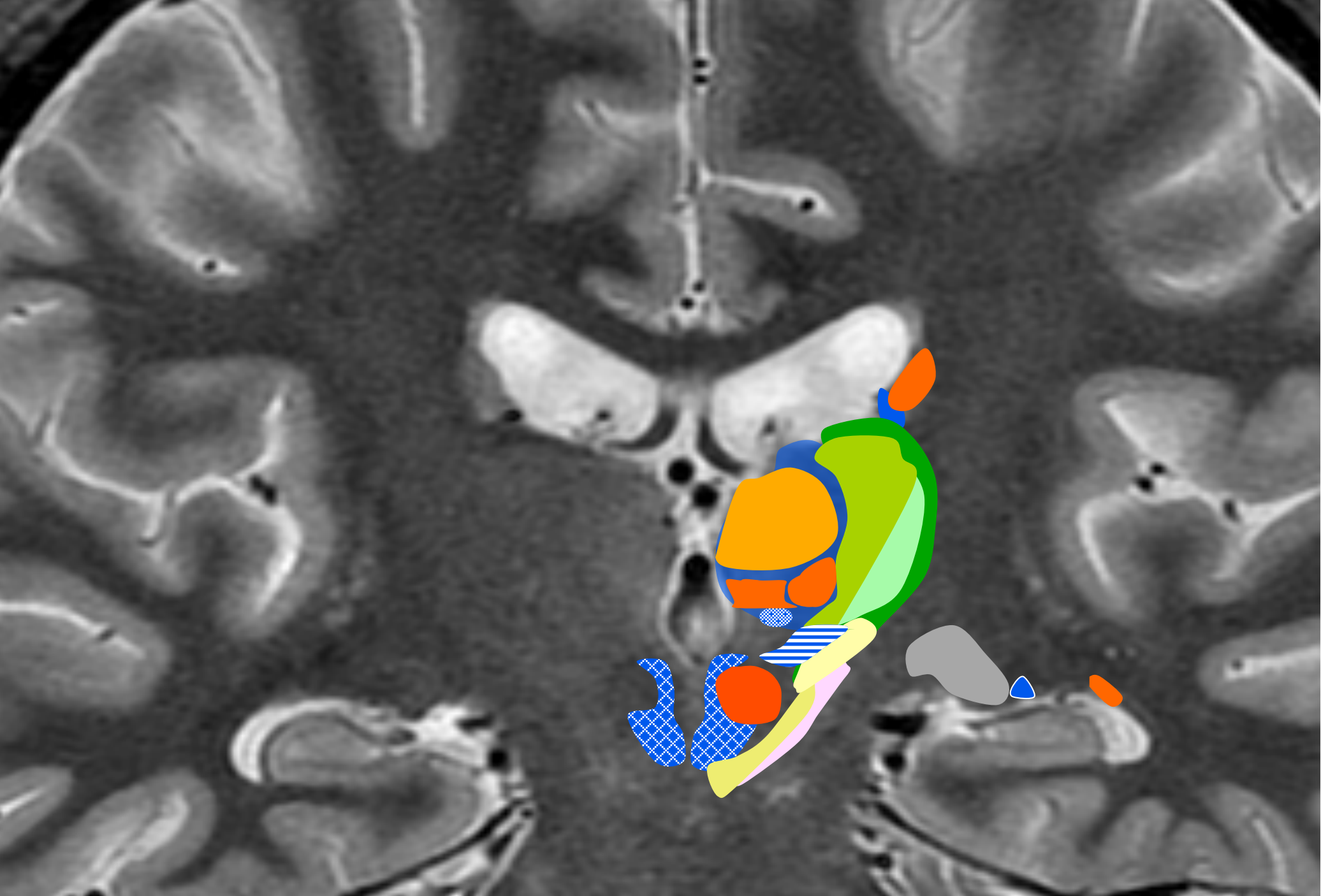


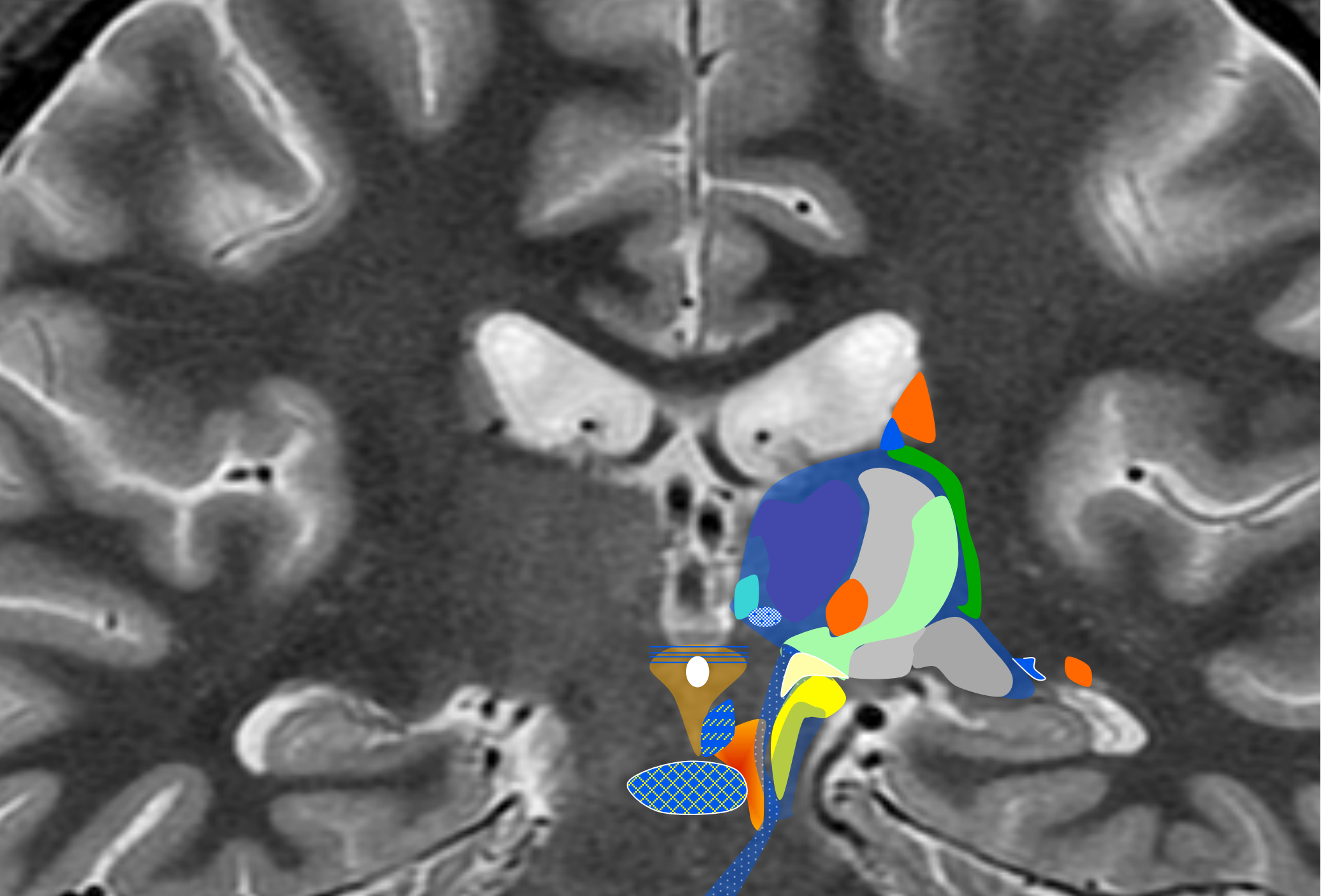


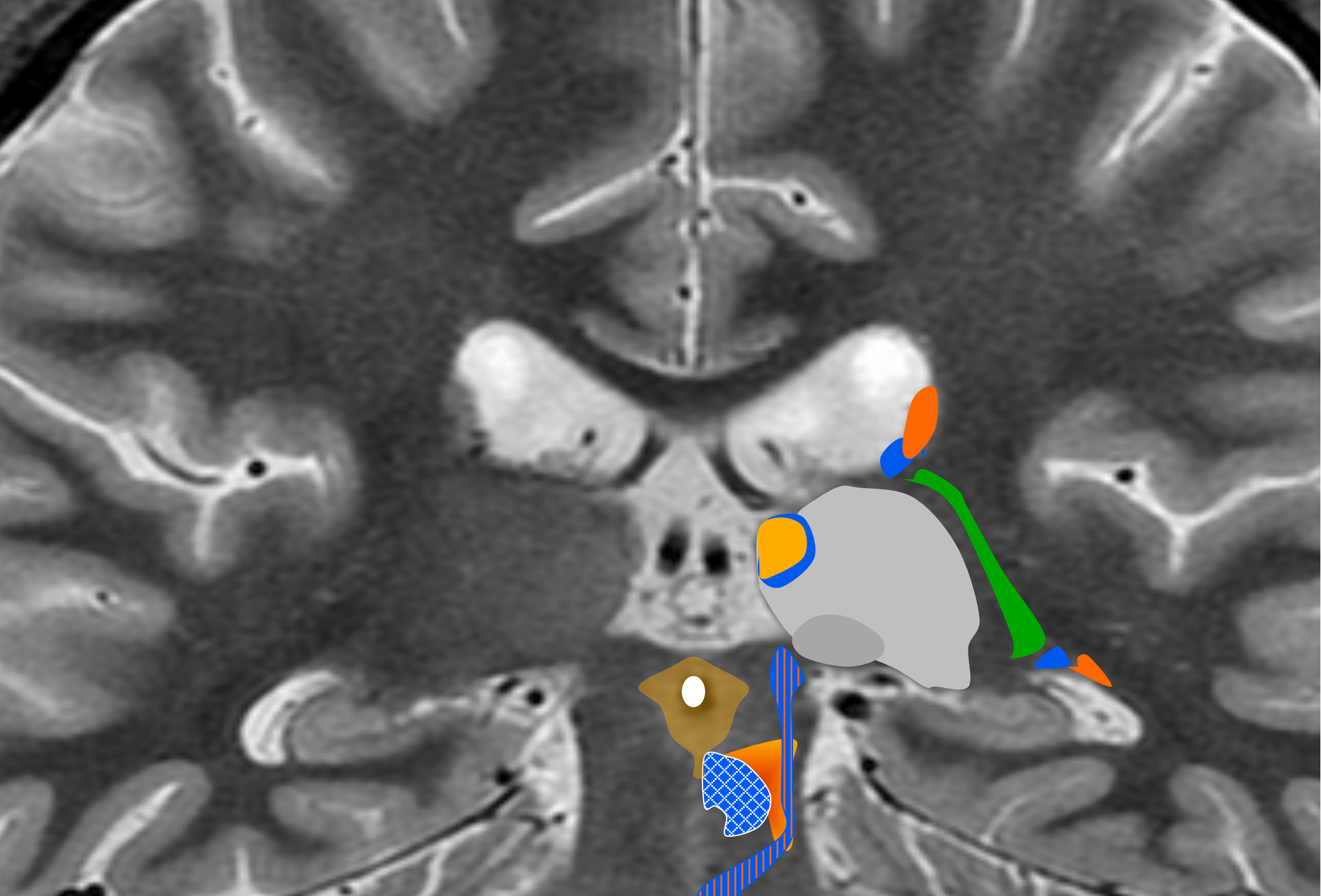




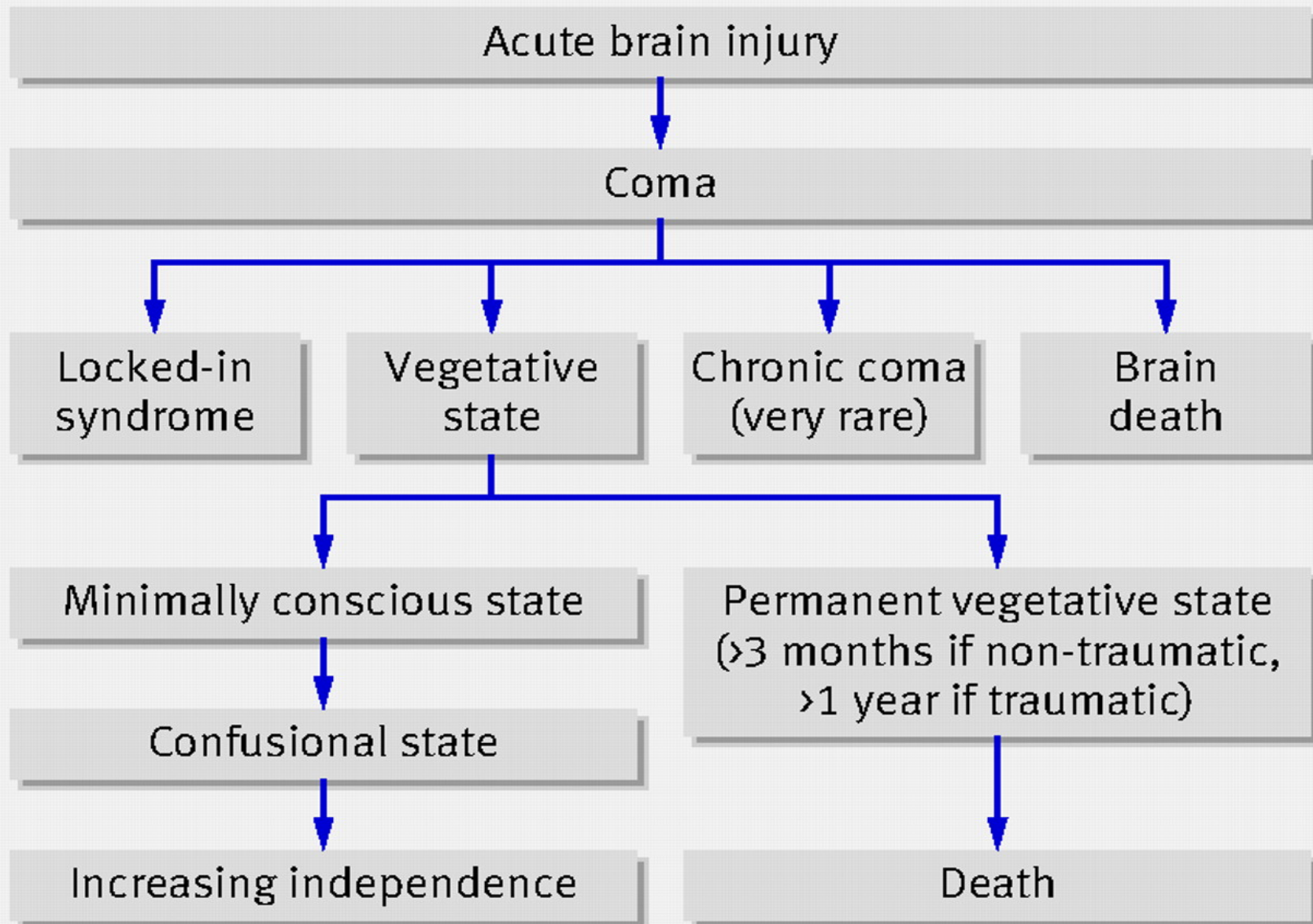








Disorders of consciousness



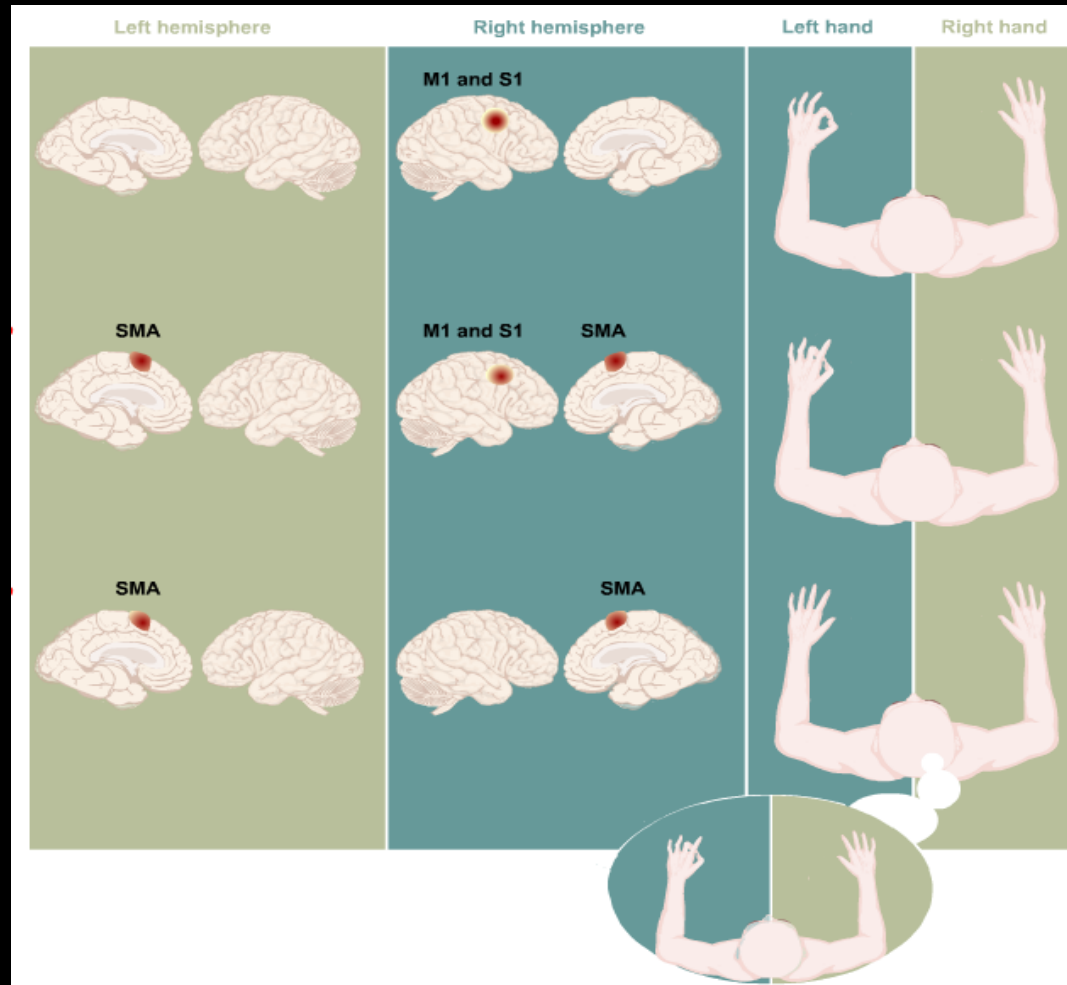
Disorders of consciousness

- Vegetative state: behavioral presentation of wakefulness in the absence of any evidence of awareness of self or environment
- Autonomic functions with preservation of cranial and spinal reflexes but no evidence of behavioral responses or language comprehension
- Distinct from coma (no wakefulness) on one side and minimally conscious state (response to environment, e.g. smooth pursuit) on other

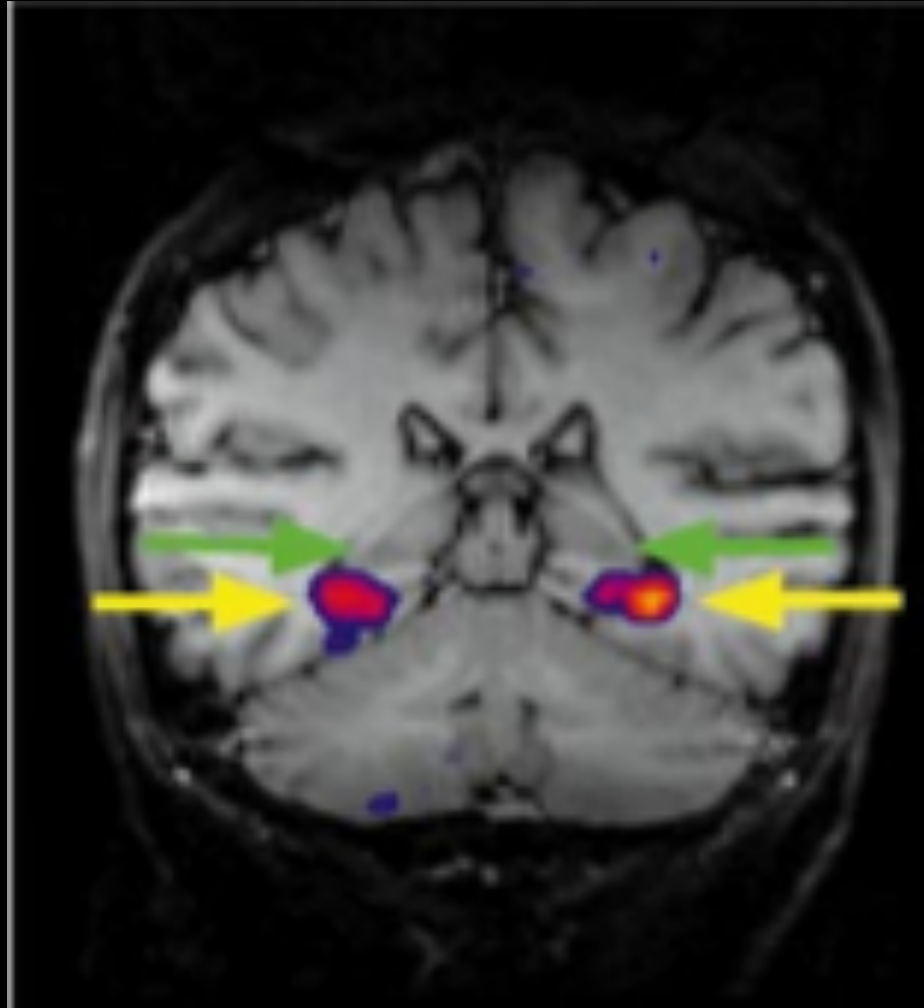
Vegetative State

- Youtube video

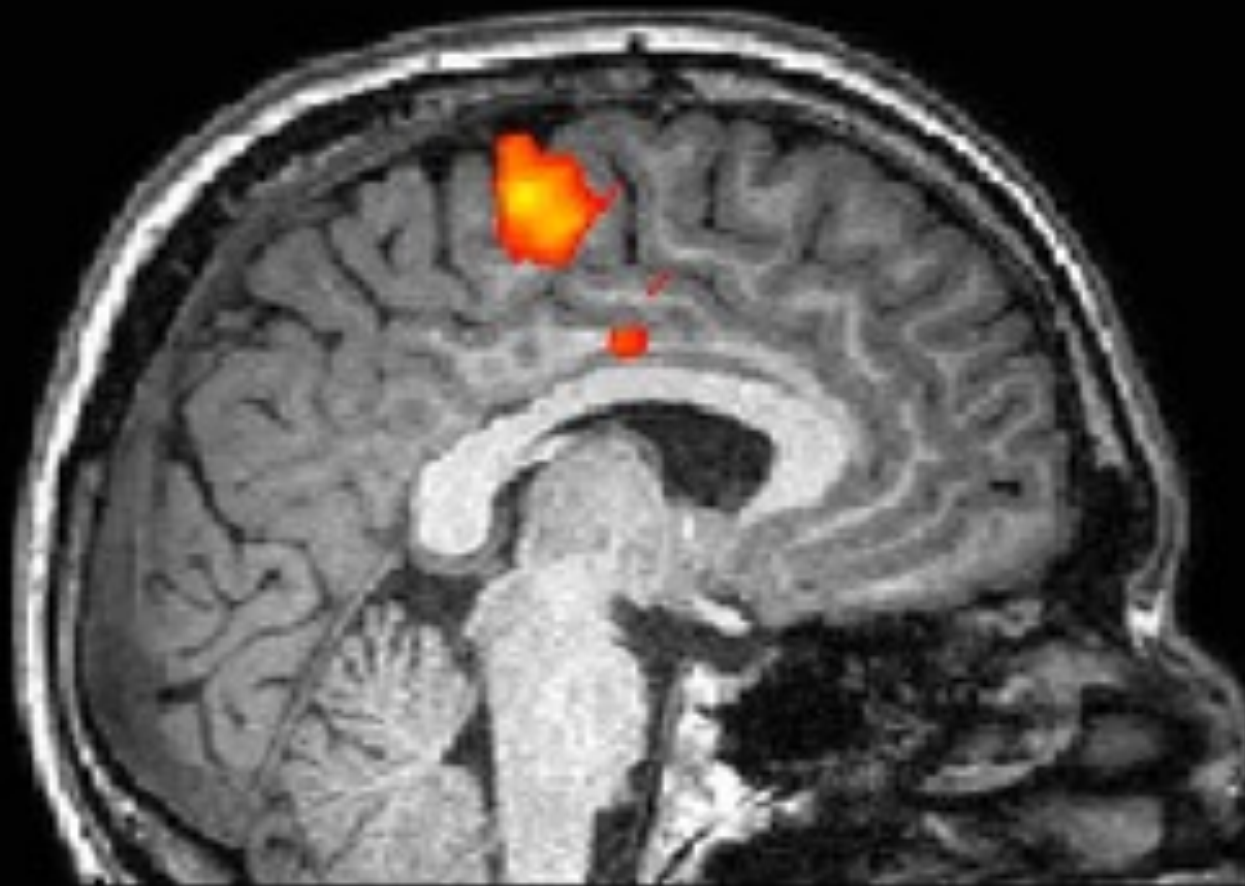
SMA for motor imagery



Parahippocampal gyrus for places (seeing and imagery)

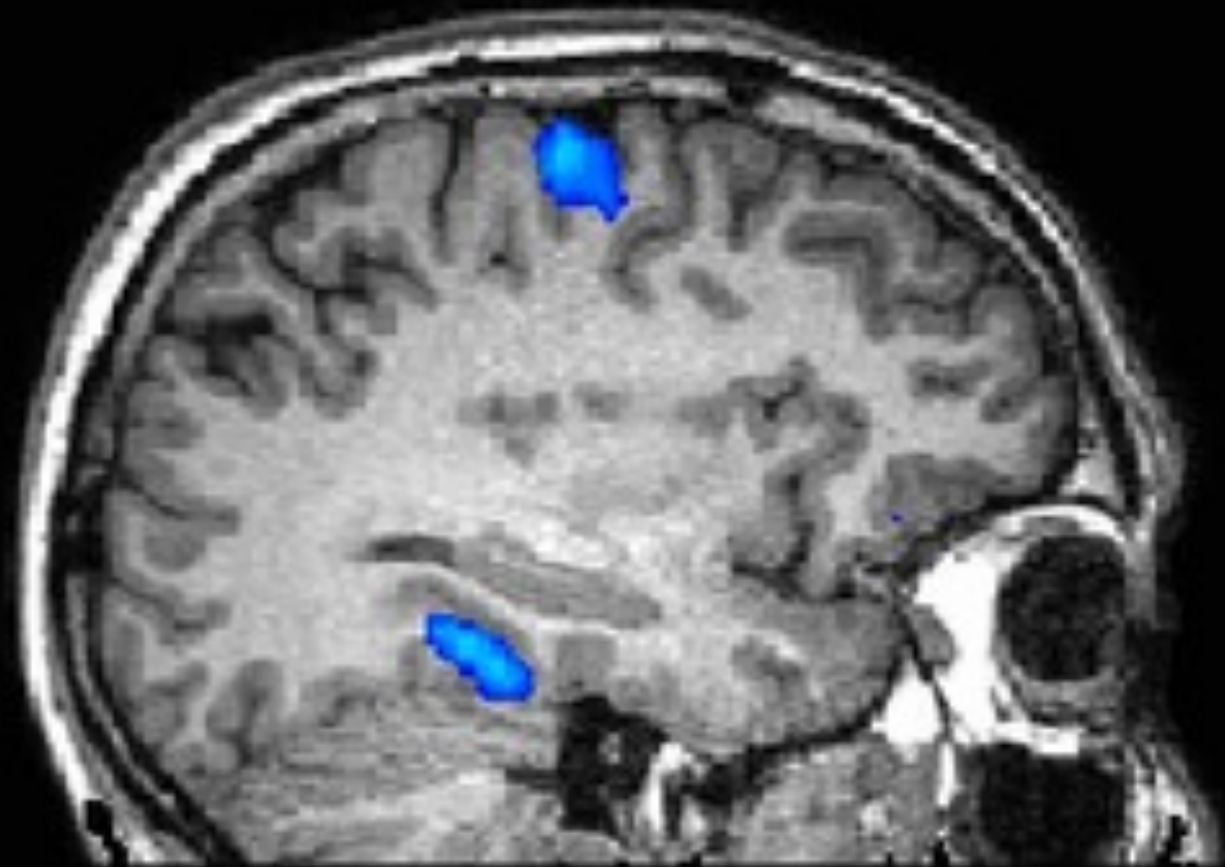


“Imagine playing tennis”



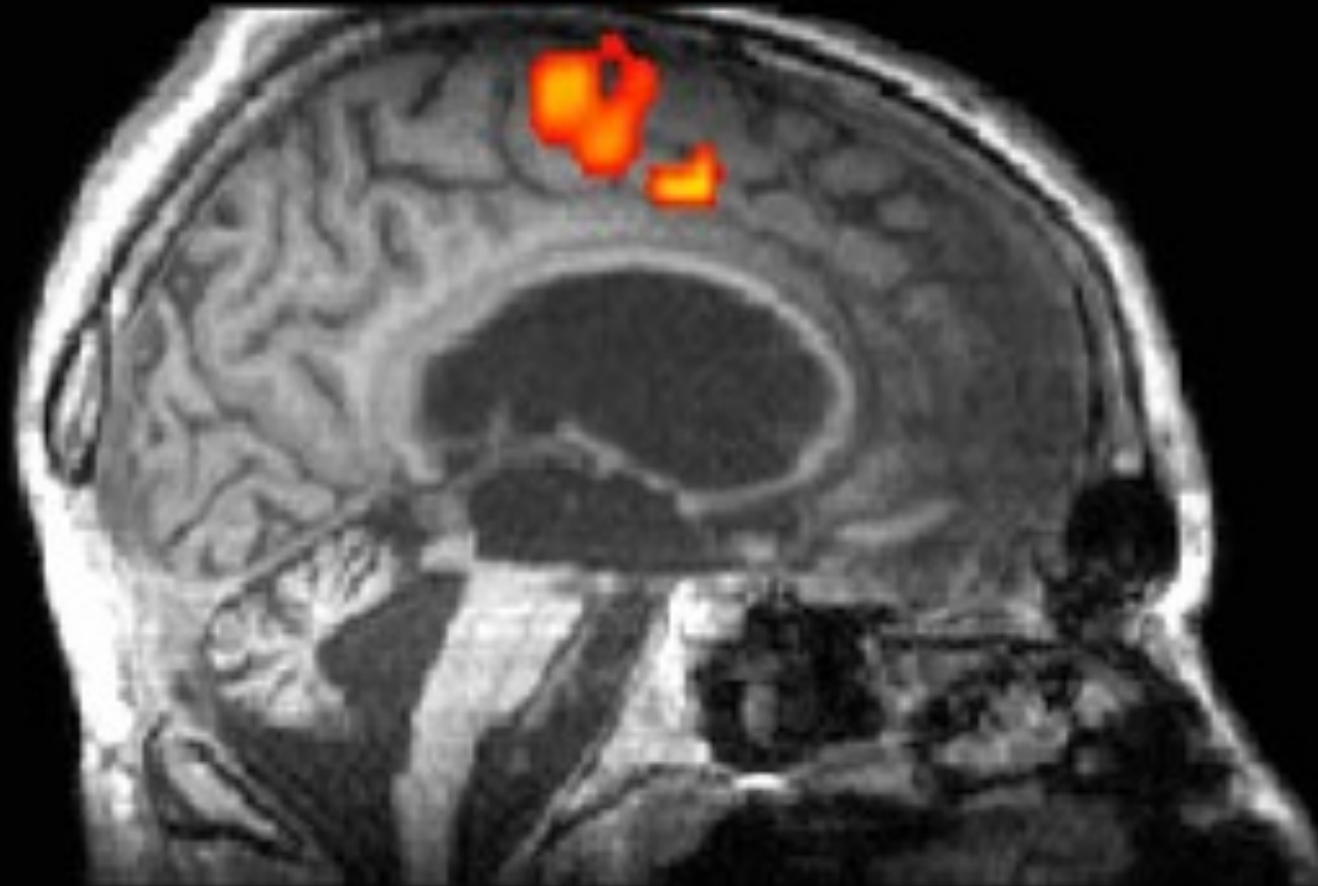
Monti *et al.* *NEJM* (2010)

“Imagine walking through your house”



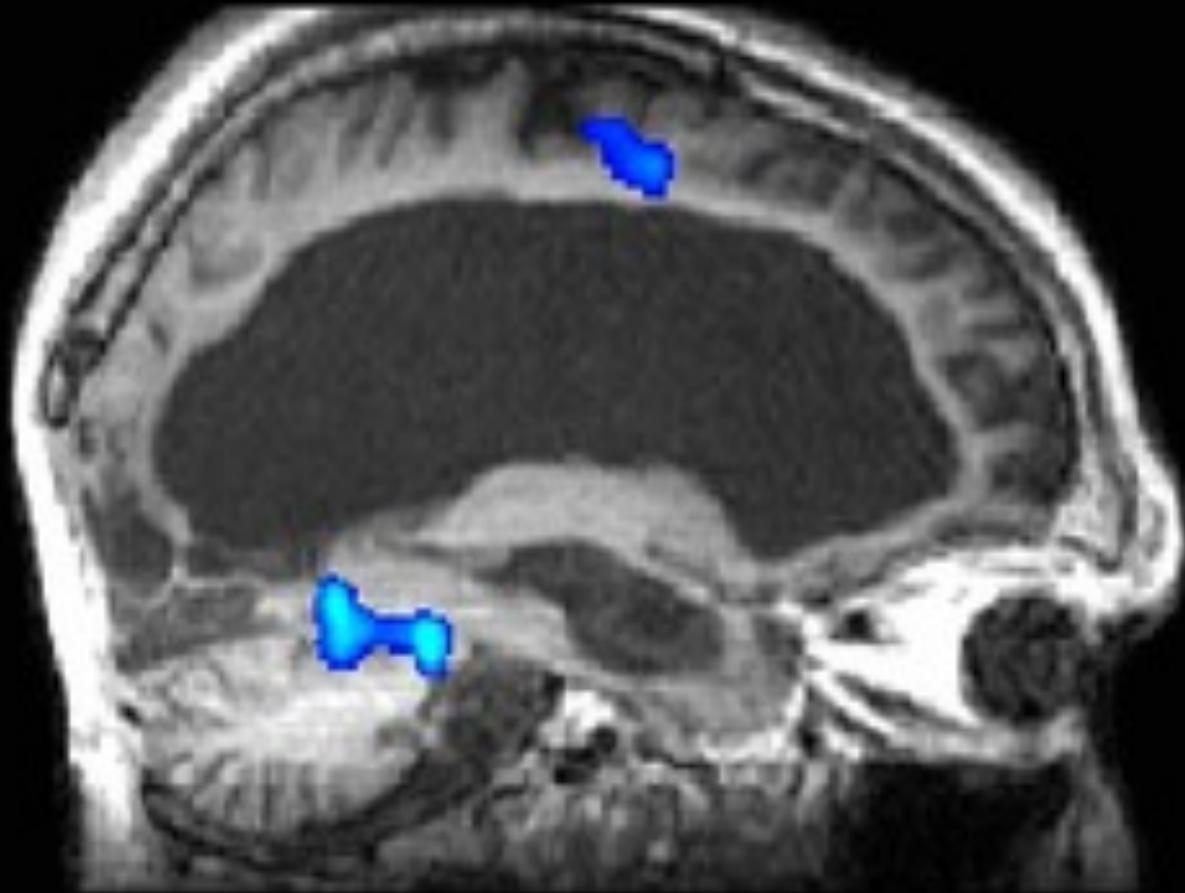
Monti *et al.* *NEJM* (2010)

“Imagine playing tennis”



Monti *et al.* *NEJM* (2010)

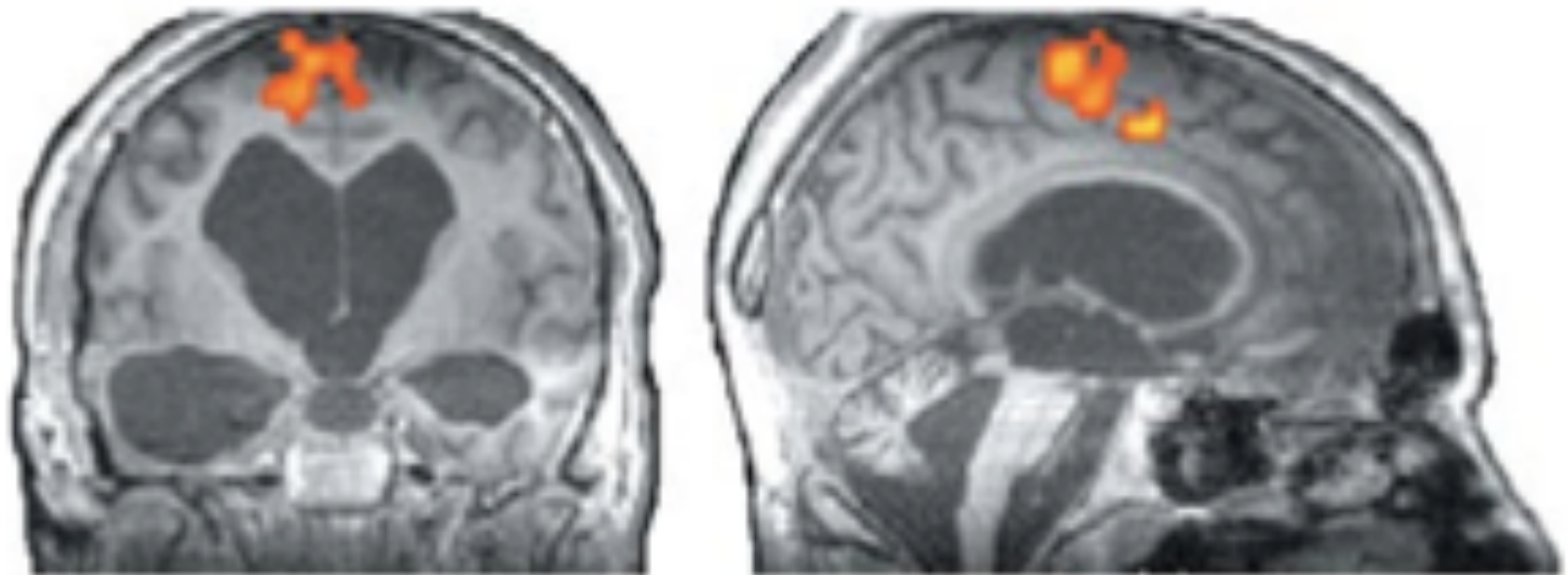
“Imagine walking through your house”



Monti *et al.* *NEJM* (2010)

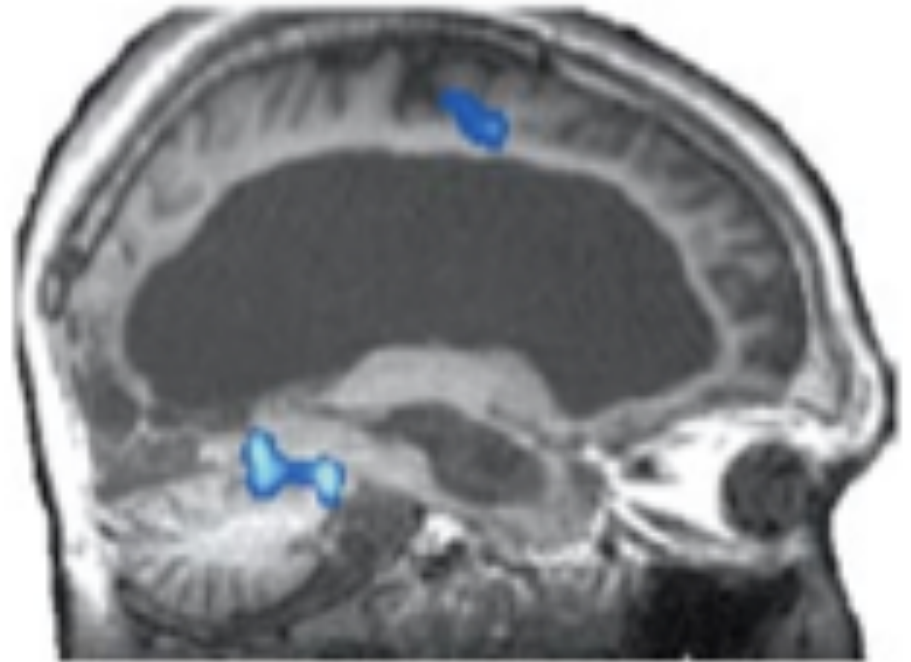
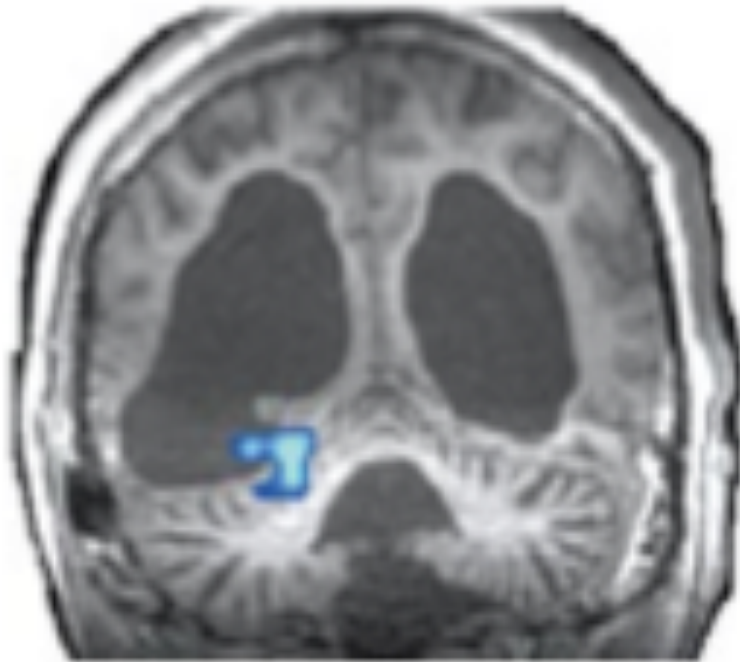
20 questions....

“Is your father’s name Alexander?” “Yes” response with the use of motor imagery



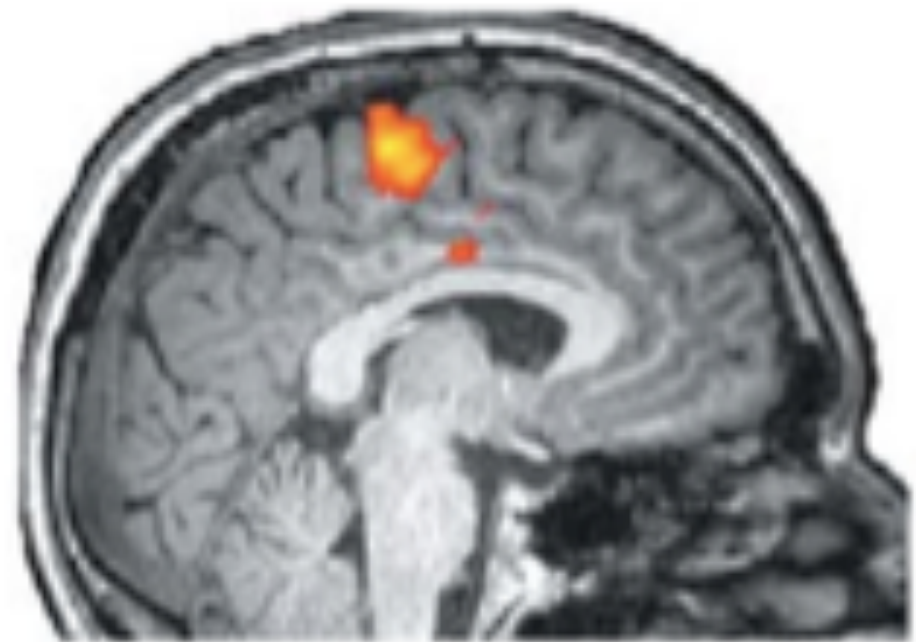
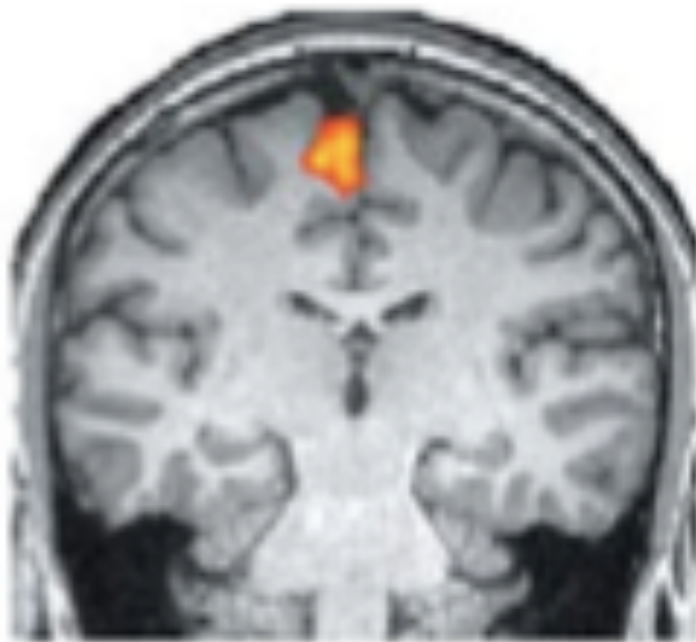
20 questions....

"Is your father's name Thomas?" "No" response with the use of spatial imagery



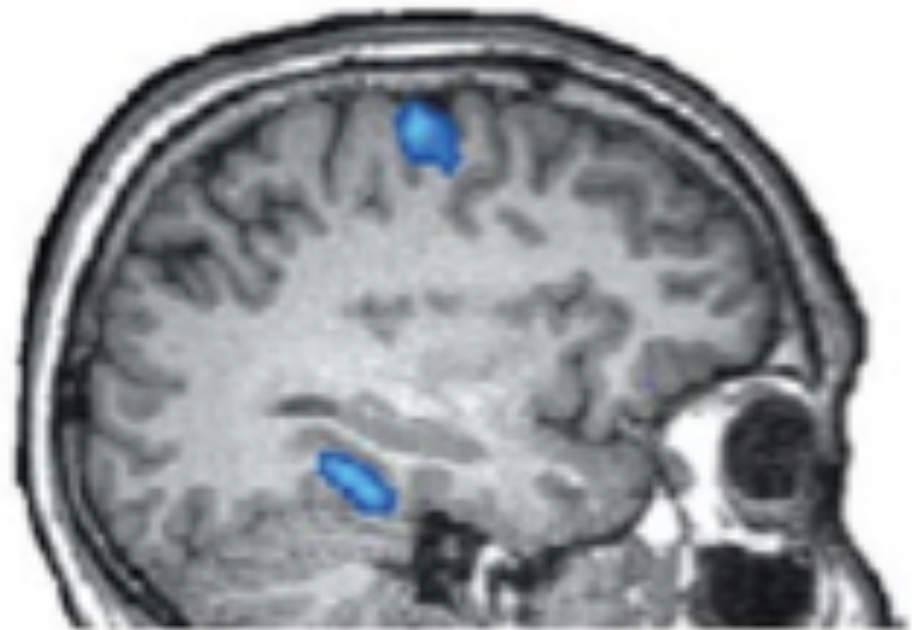
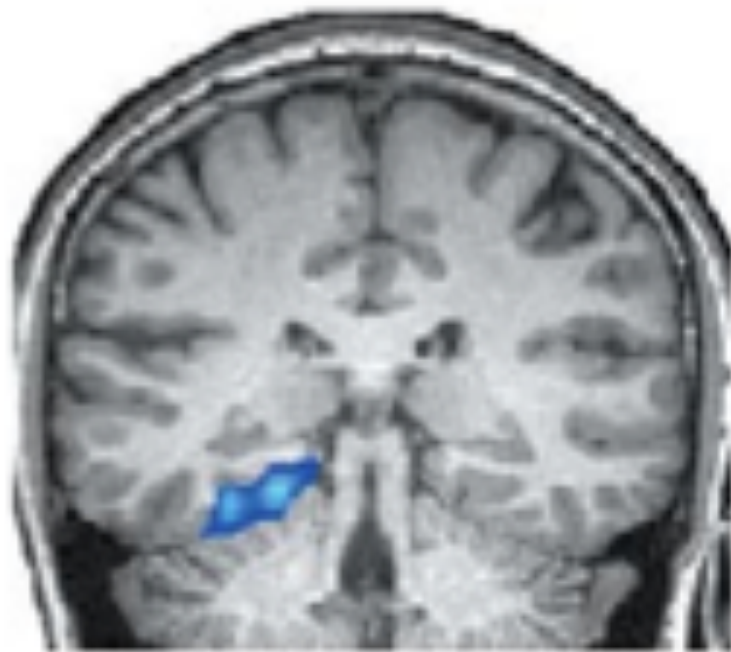
20 questions....

“Do you have any brothers?” “Yes” response with the use of motor imagery



20 questions....

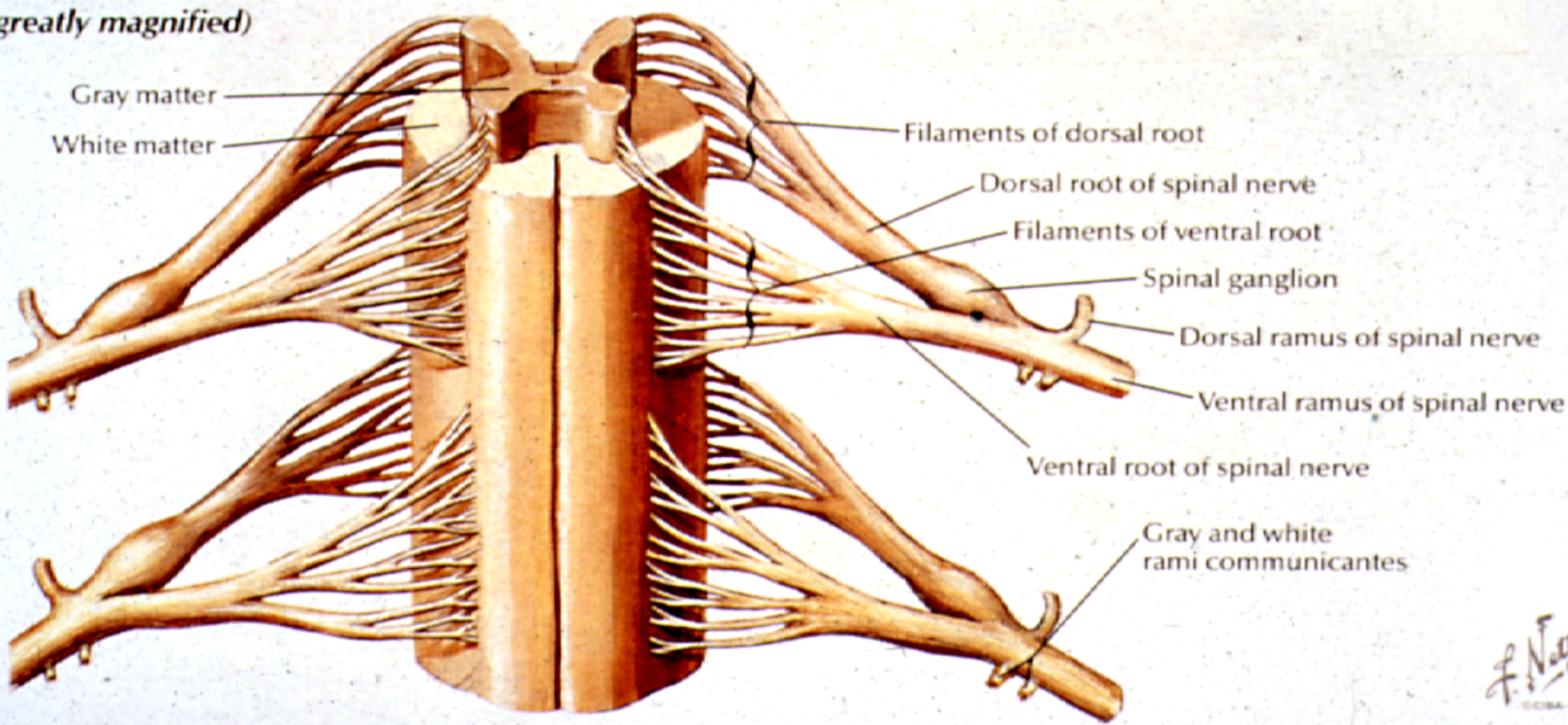
"Do you have any sisters?" "No" response with the use of spatial imagery



Conclusion

- At least some of these patients are not “vegetative” or “minimally conscious” at all!

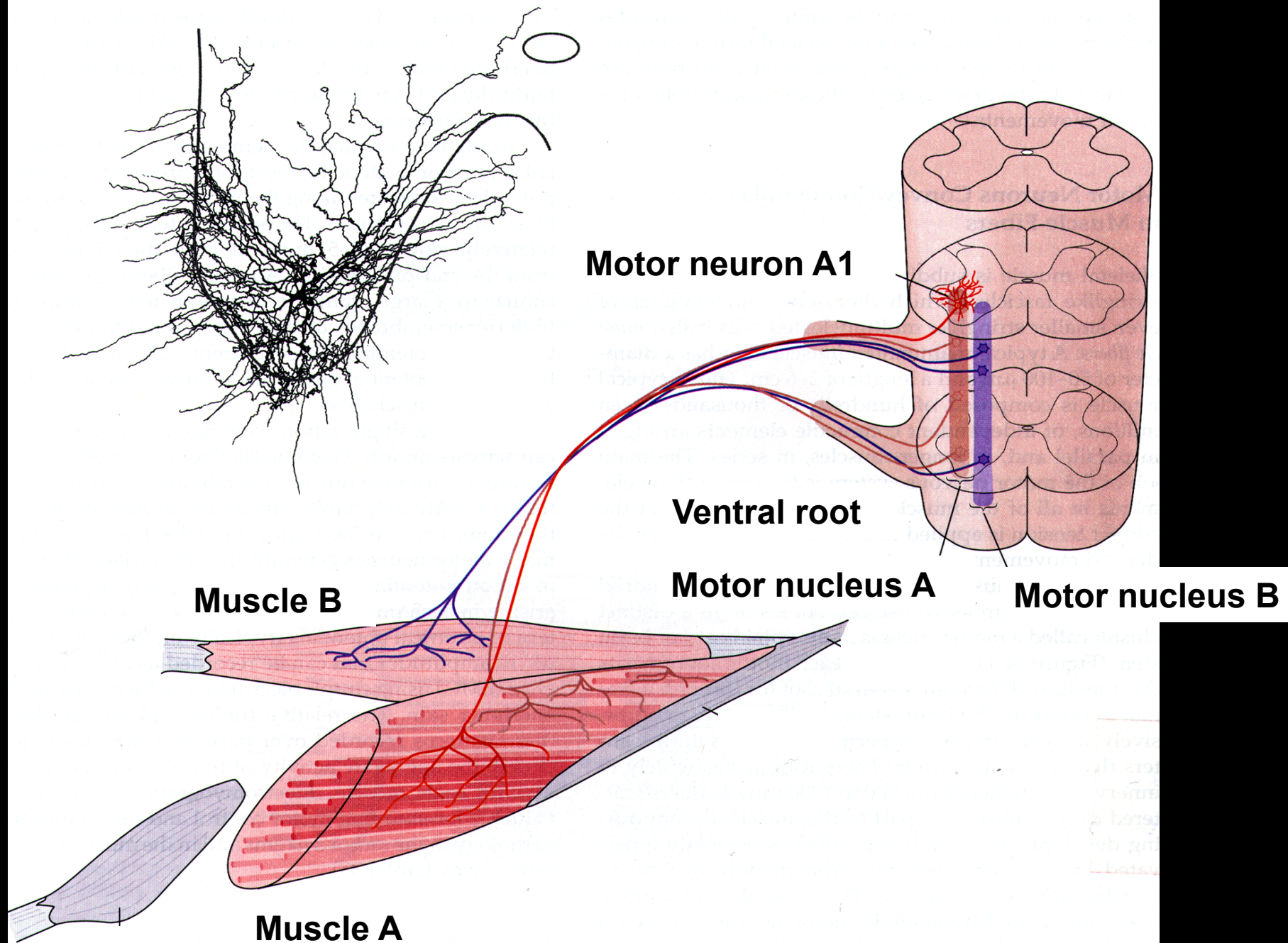
Membranes removed: anterior view
(greatly magnified)



F. Netter
M.D.
© CIBA-GEIGY

Lower Motor Neuron Syndrome

- Effects limited to small groups of muscles
- Muscle atrophy
- Weakness
- Fasciculation/fibrillation
- Decrease in muscle tone (hypotonia)
- Absent reflexes (hyporeflexia)



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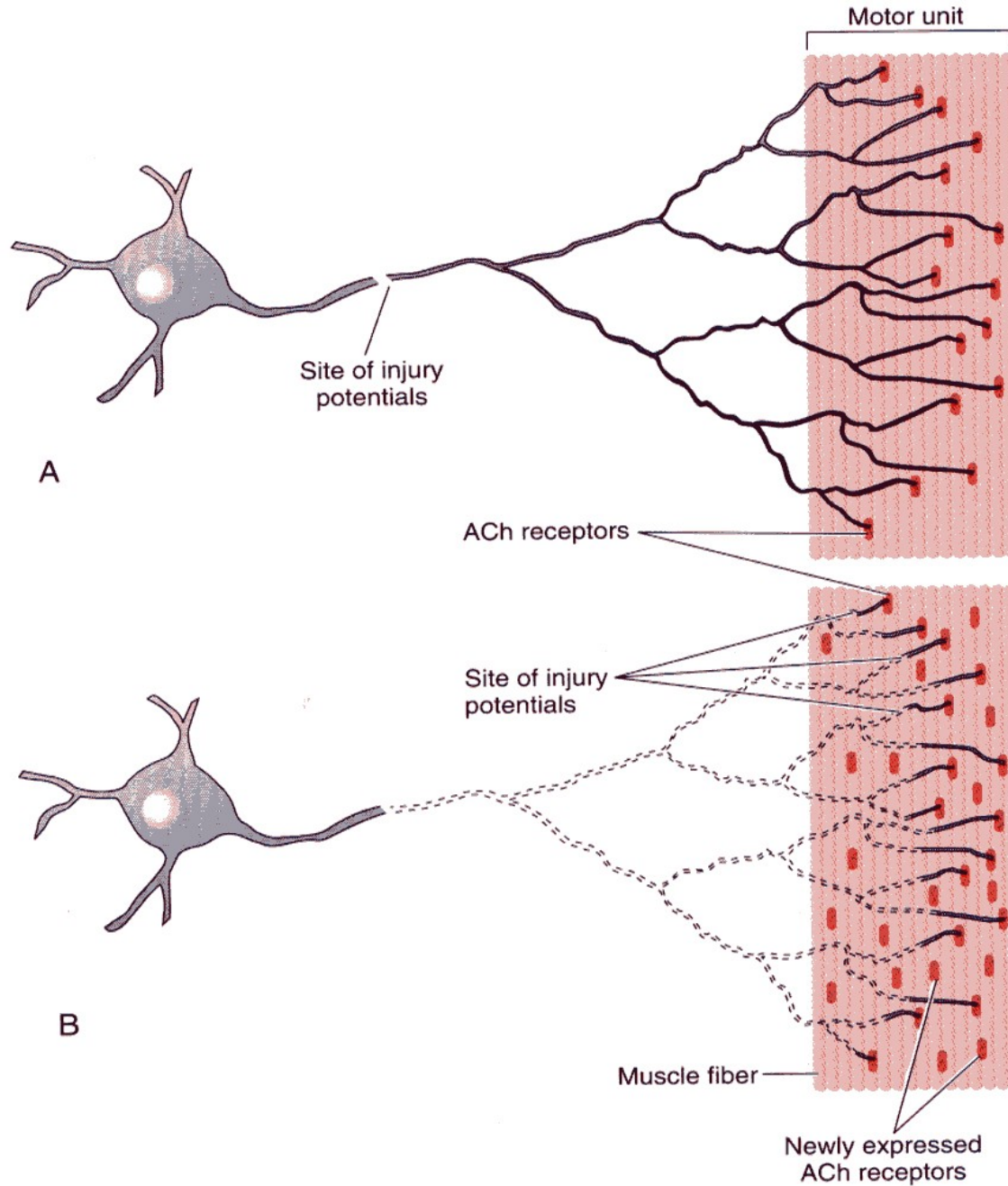


Figure 6.13 Effects of muscle denervation

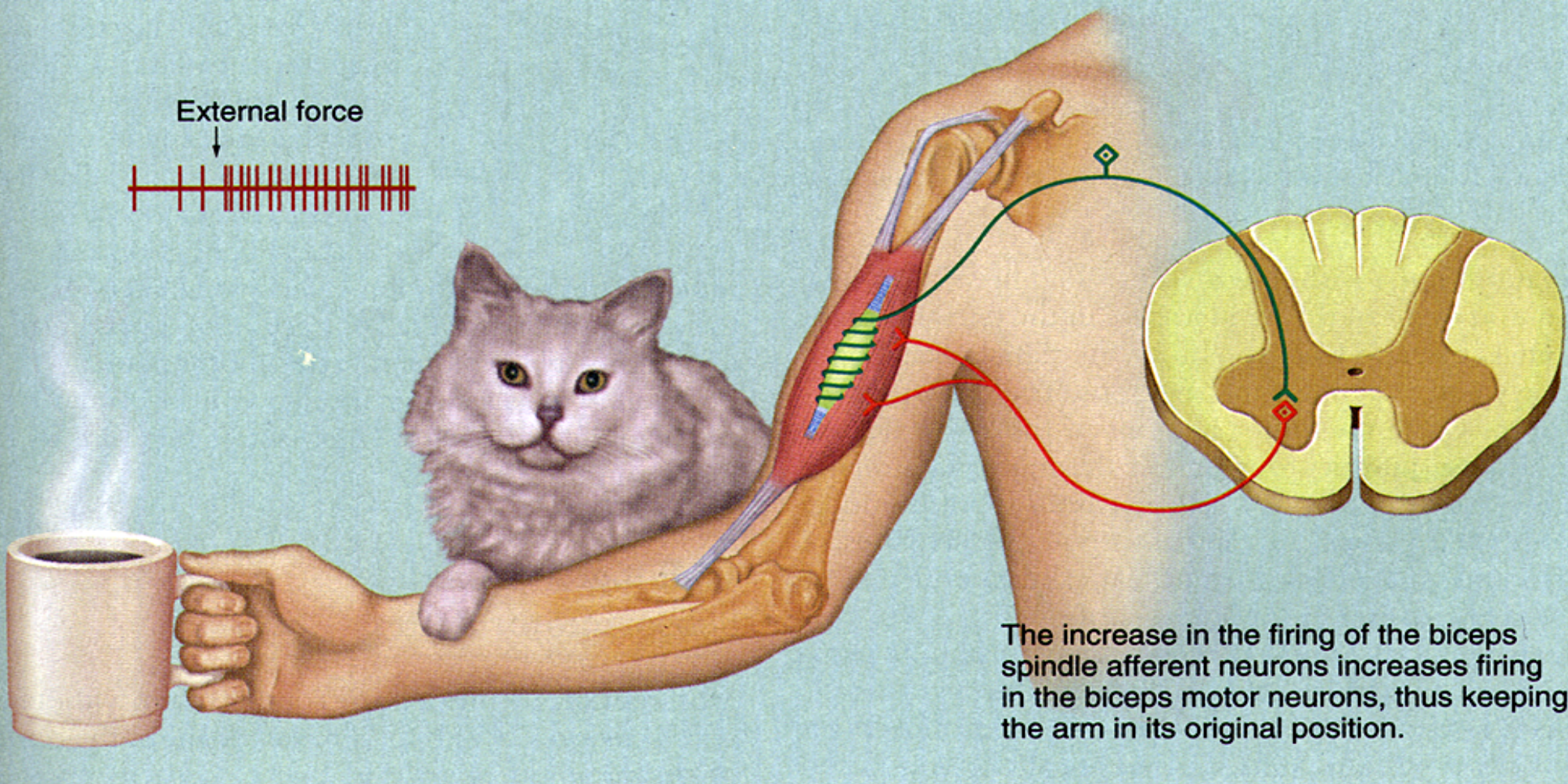
Lower Motor Neuron Syndrome

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External force



The increase in the firing of the biceps spindle afferent neurons increases firing in the biceps motor neurons, thus keeping the arm in its original position.

Descending Spinal Pathways

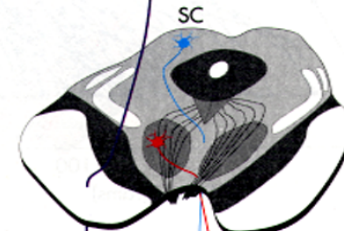
(from Nolte, p. 438)

Upper Motor Neurons

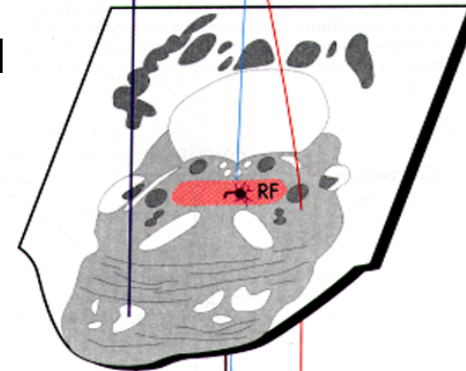
Precentral
gyrus



Rostral
midbrain



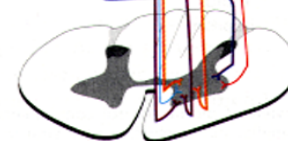
Caudal
pons



Rostral
medulla



Cervical
spinal cord



Upper Motor Neuron Syndrome

- Effects extend to large groups of muscles
- Atrophy is rare
- Weakness (paresis, not plegia)
- No fasciculation/fibrillation
- Increase in muscle tone (hypertonia)
- Hyperreflexia
- Clonus
- Initial contralateral flaccid paralysis
- Spasticity
- Babinski sign

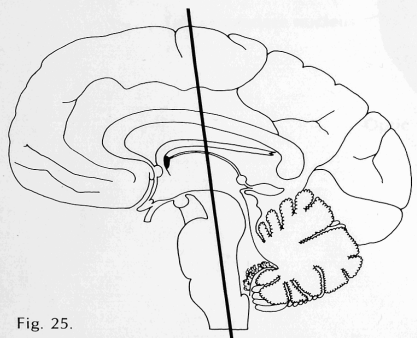
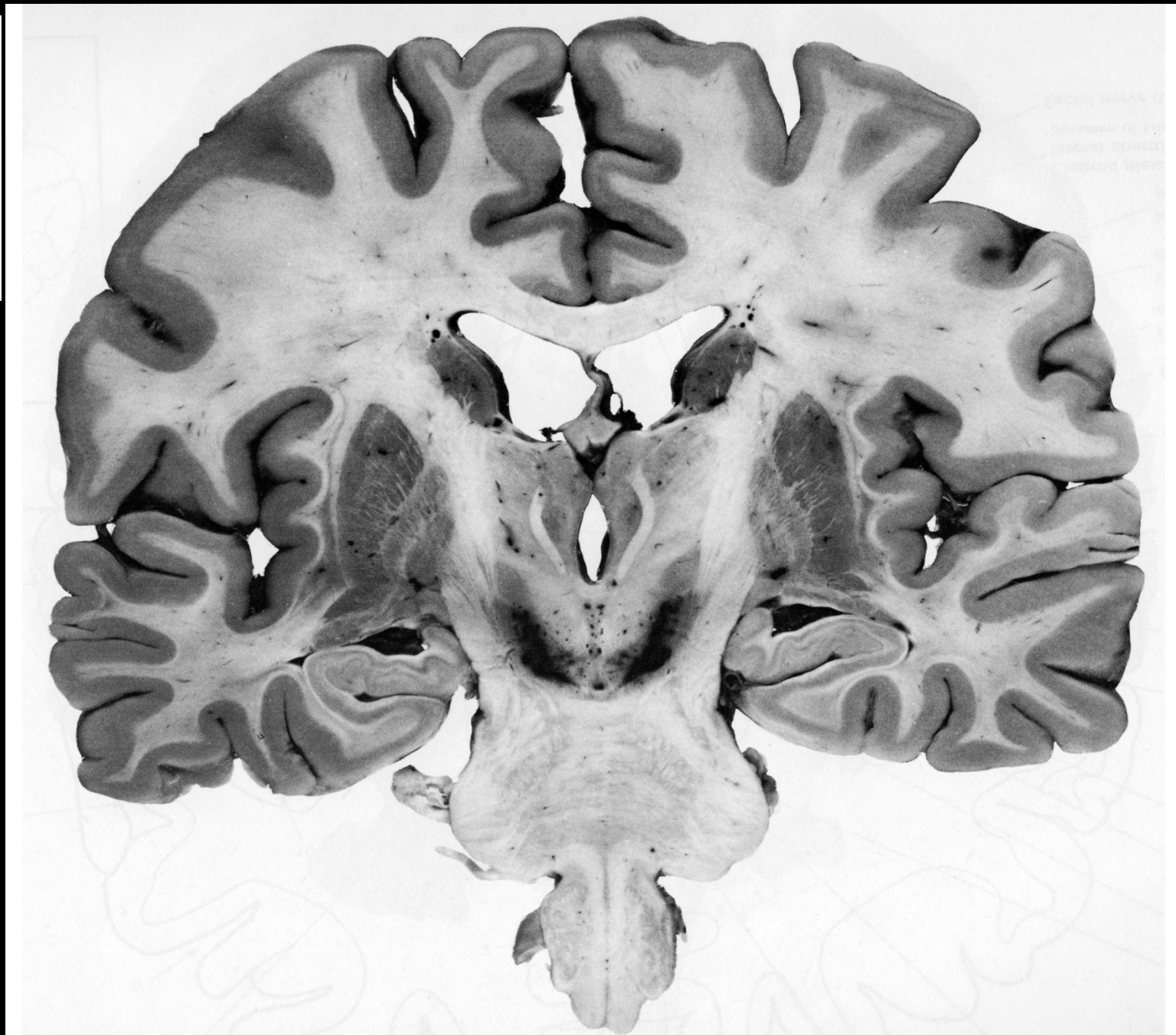
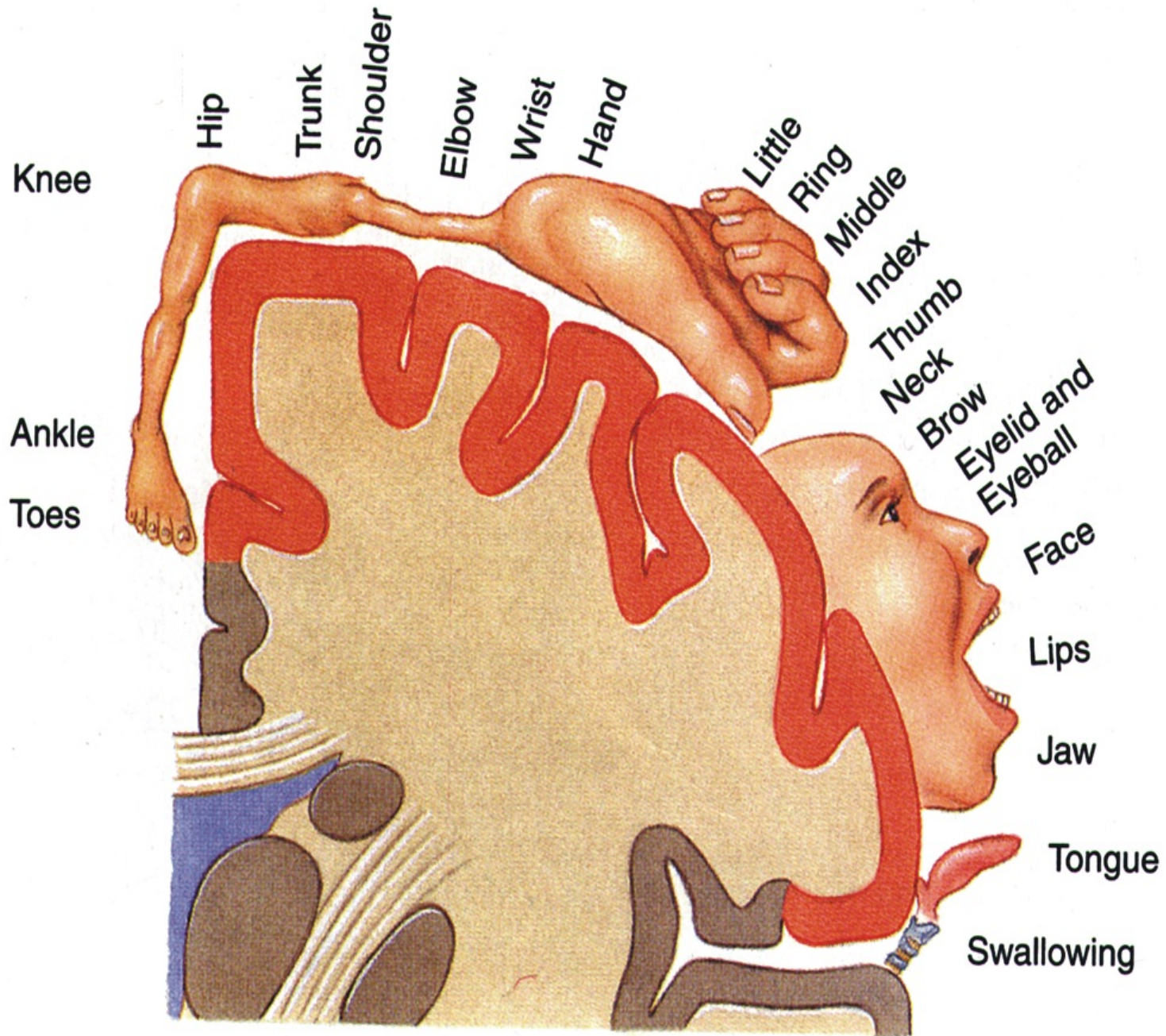


Fig. 25.



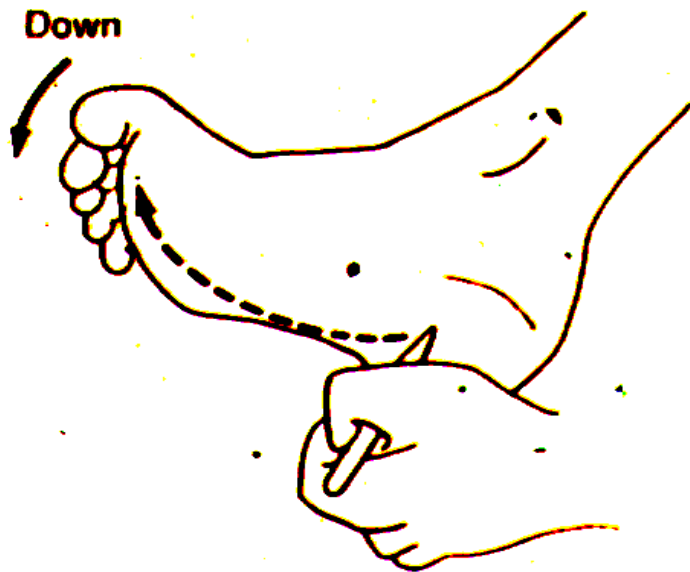
DeArmond Fig. 25



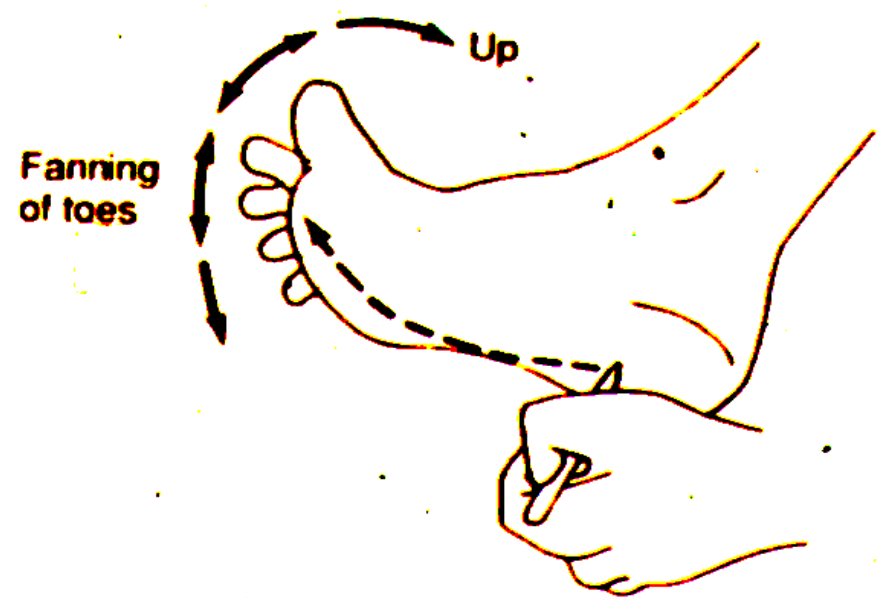
Upper Motor Neuron Syndrome

- Effects extend to large groups of muscles
- Atrophy is rare
- Moderate weakness (paresis, not plegia)
- No fasciculation/fibrillation
- Increase in muscle tone (hypertonia)
- Hyperreflexia
- Clonus
- Initial contralateral flaccid paralysis
(eventual recovery of some movement)
- Spasticity (“clasp-knife reflex”)
- Babinski sign

Normal plantar response



**Extensor plantar response
(Babinski sign)**



Lesions of Higher Motor Cortical Areas (premotor, supplementary)

- Impairments in motor planning and strategies
- Unable to perform complex motor tasks (apraxia)

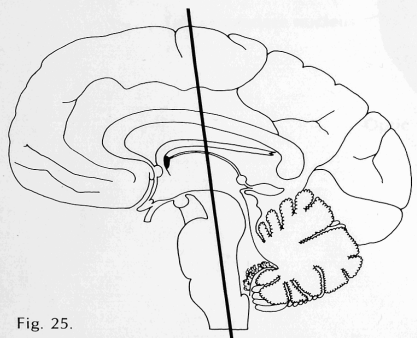
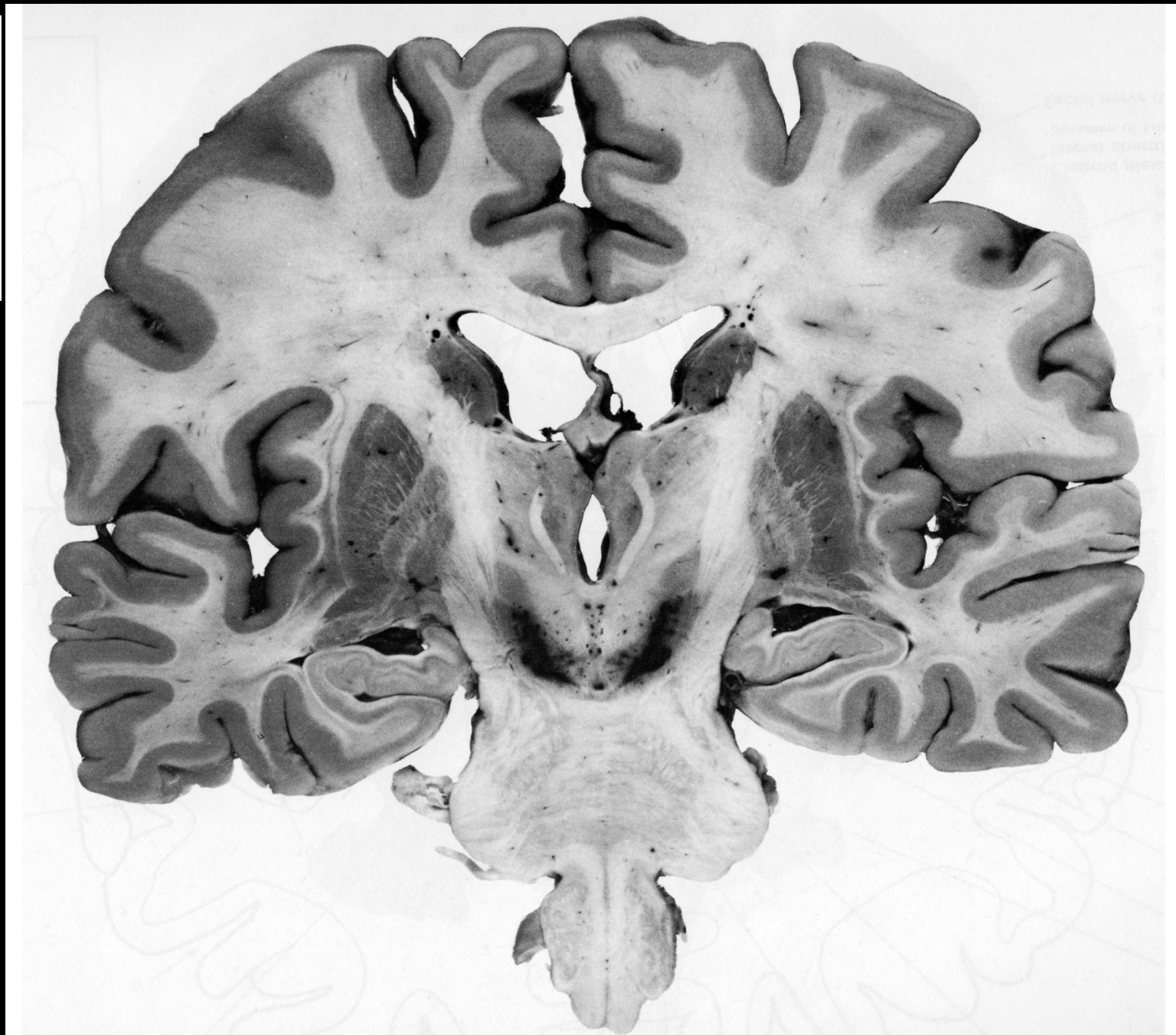


Fig. 25.



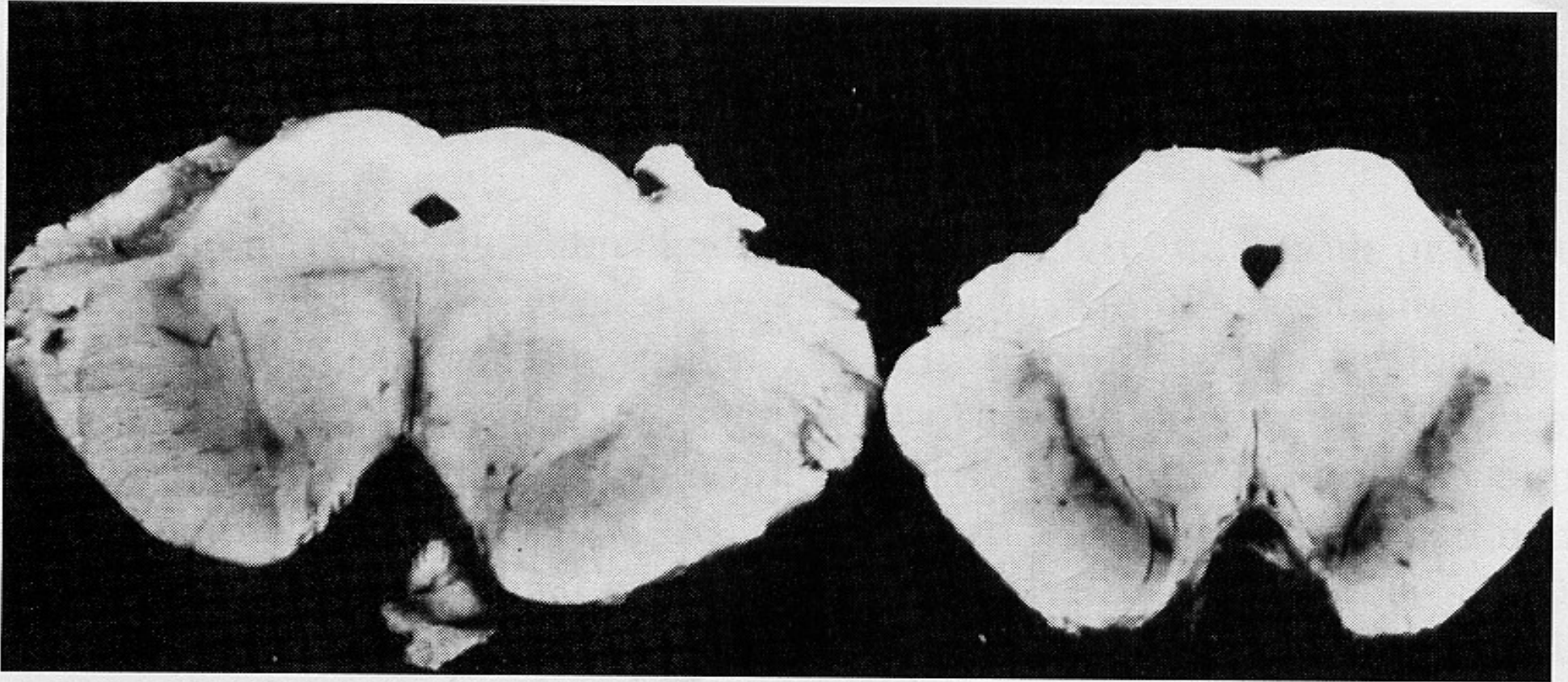
DeArmond Fig. 25

Disorders of the Basal Ganglia

Dyskinesia: abnormal involuntary movements:

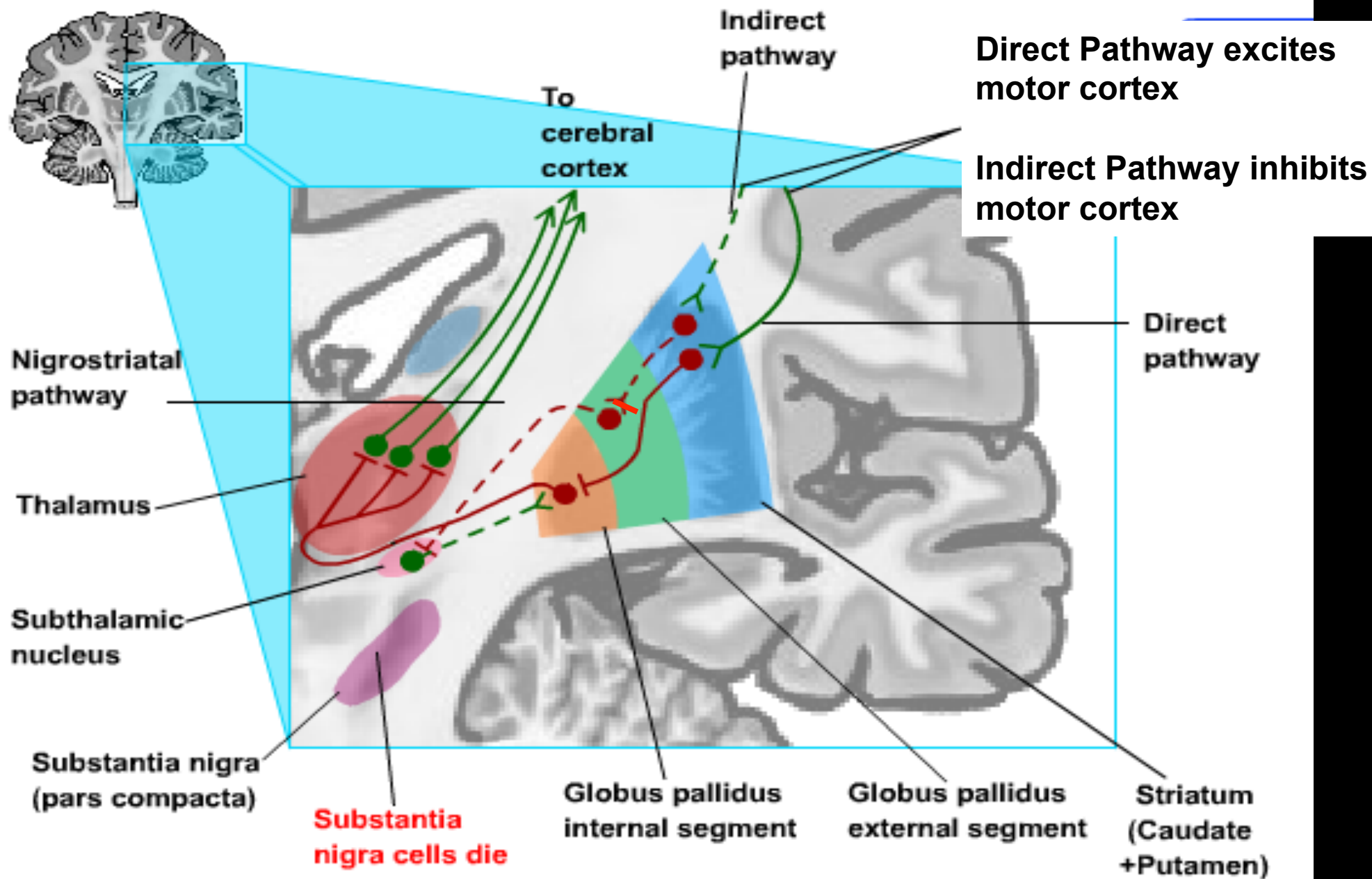
- Resting tremor (“pill-rolling tremor”)
 - Athetosis (slow, writhing movements of extremities)
 - Chorea (jerky, random movements of limbs and face)
 - Ballismus (violent, large movements of proximal limbs)
 - Tardive dyskinesia
-
- Akinesia: abnormal involuntary posture
 - Rigidity (resistance to passive movement; “lead-pipe rigidity, cog-wheel rigidity”)
 - Dystonia (abnormal postures from contraction of agonist & antagonist muscles)
 - Bradykinesia

Parkinson's Disease

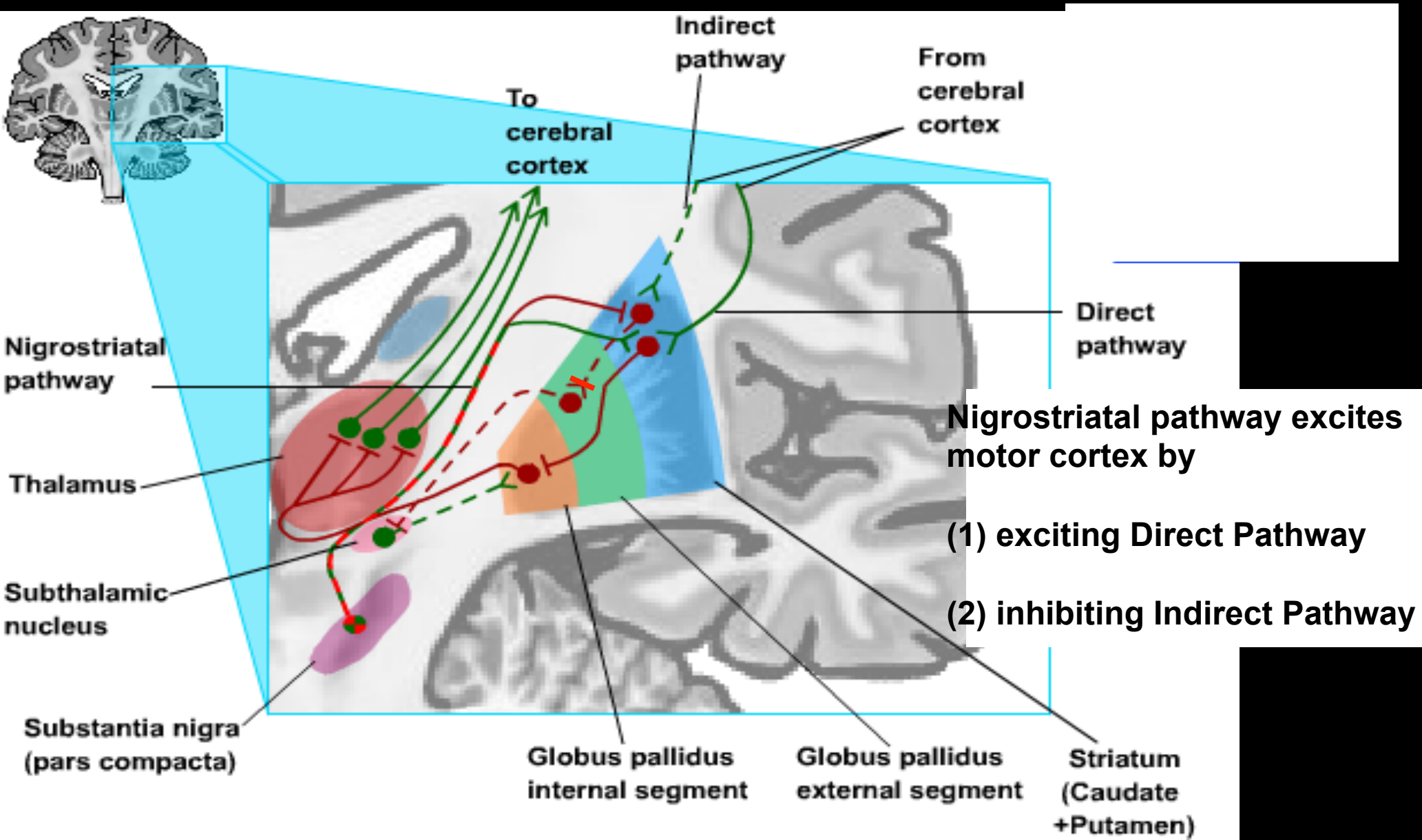


From Kingsley RE (2000) *Concise Text of Neuroscience, 2nd Ed.*

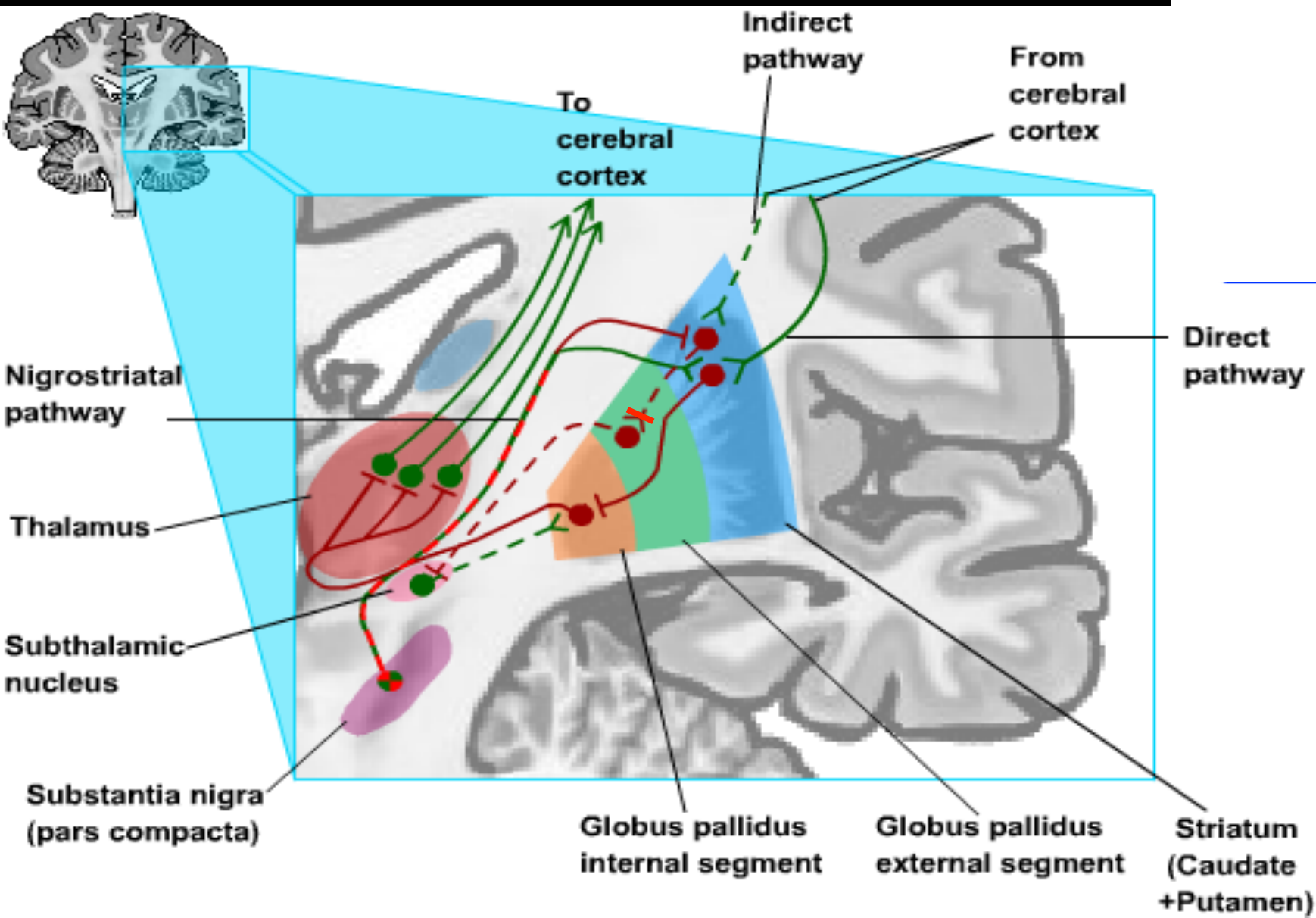
Direct and Indirect Pathways



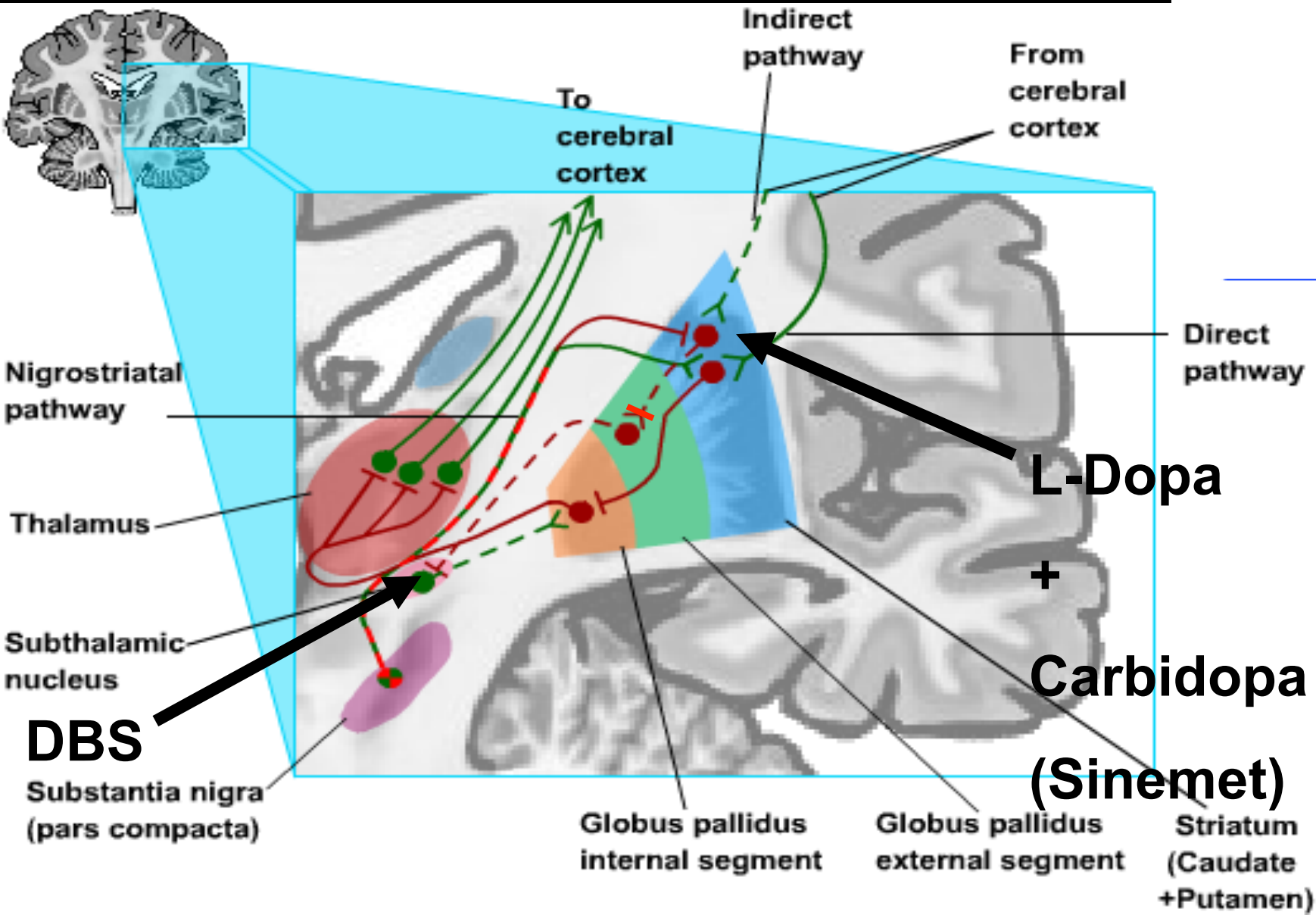
Dopaminergic Input from Substantia Nigra



Parkinson's Disease



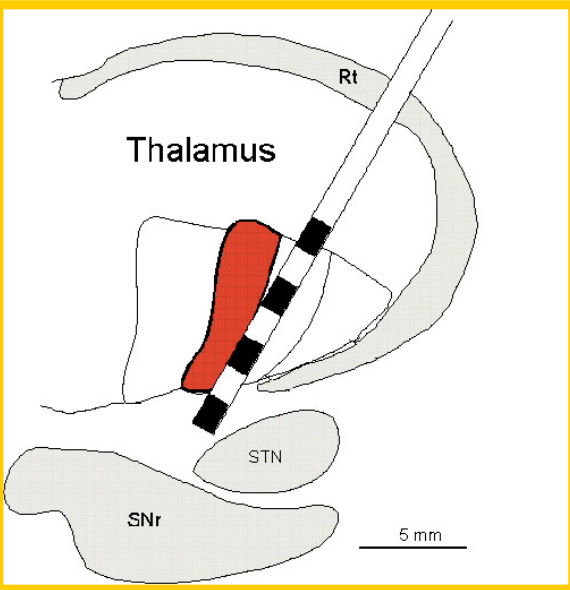
Parkinson's Disease Treatments



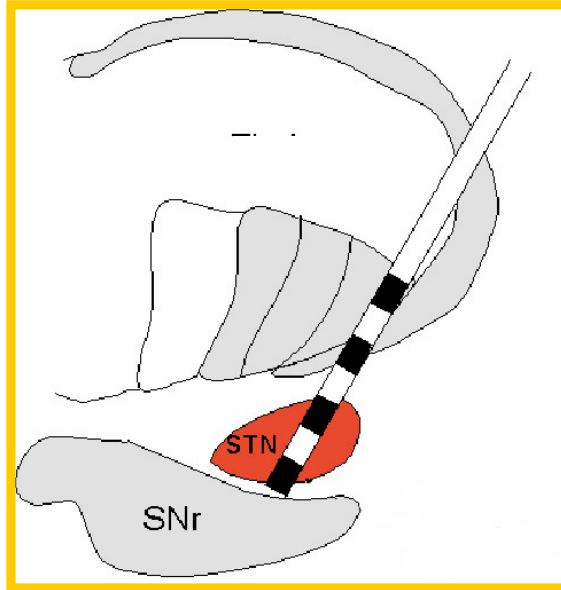
Deep brain stimulation for movement disorders

- Mechanics:
- Pre-implantation MRI
- Sterotaxy (frameless or not)
- Recording to ensure correct placement
- Post-surgery: Programming: pulse width, rate, amplitude

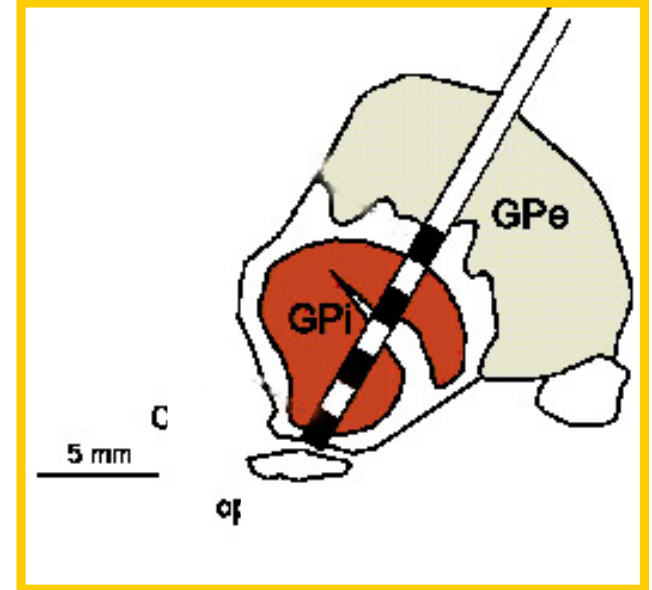
DBS targets



Vim Thalamus:
Essential tremor &
other tremor disorders

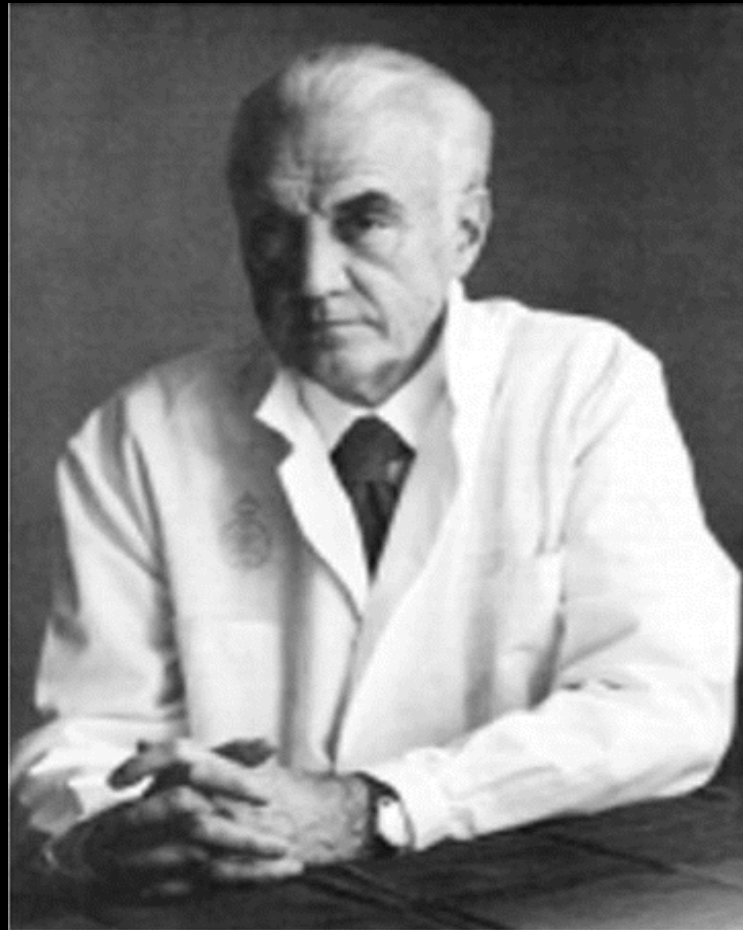


Subthalamic nucleus:
Parkinson's disease



Globus pallidus:
Parkinson's disease &
dystonia

Lars Leksell



“I was born under the sign of the ‘archer’ and look forward to sharpshoot into the brain.”

Surgical Technique: Targeting

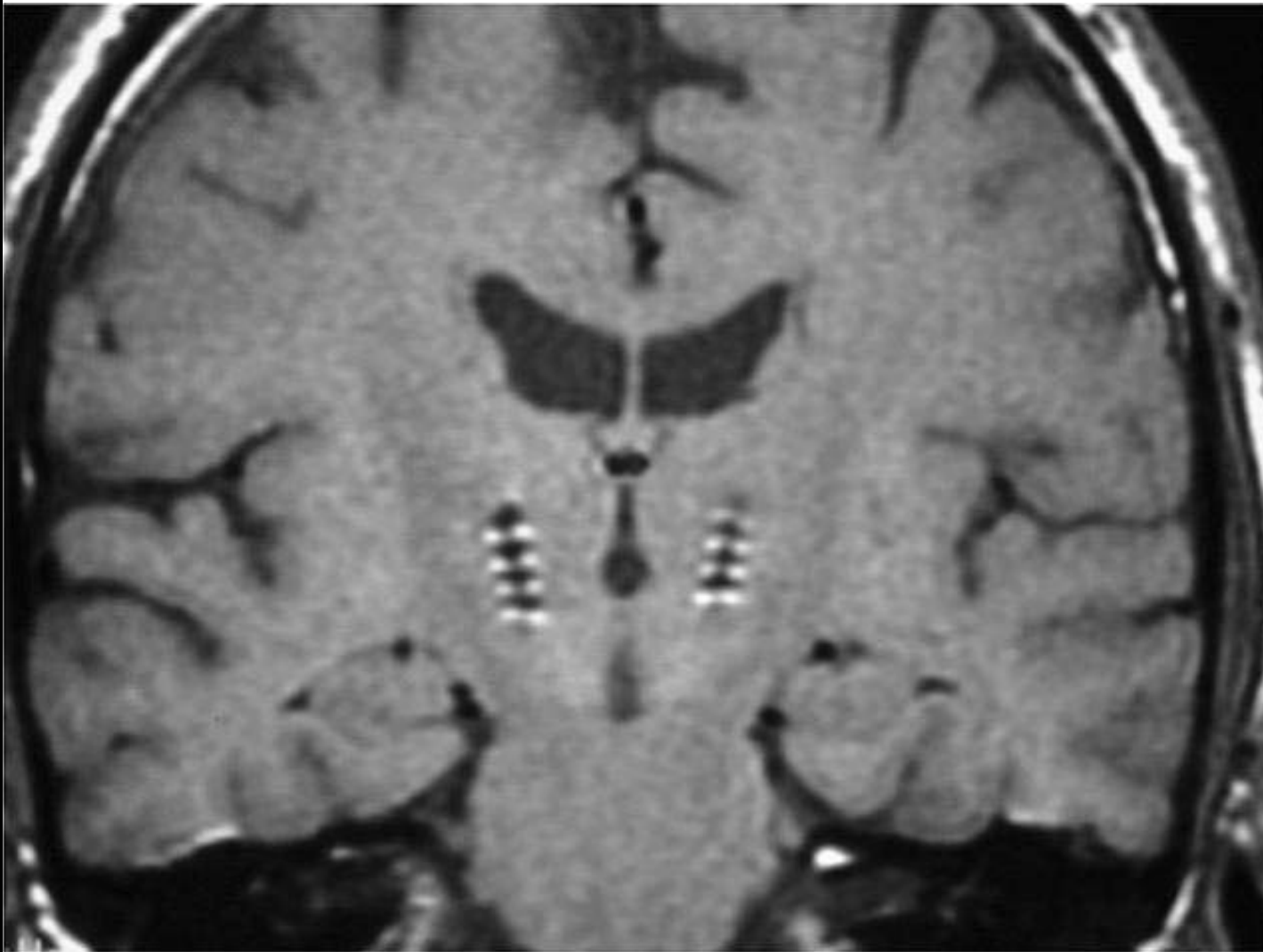
- Sophisticated imaging and software enables precise targeting for optimal outcomes and minimal risk
- Microelectrode recording (MER) offers additional levels of verification of lead location



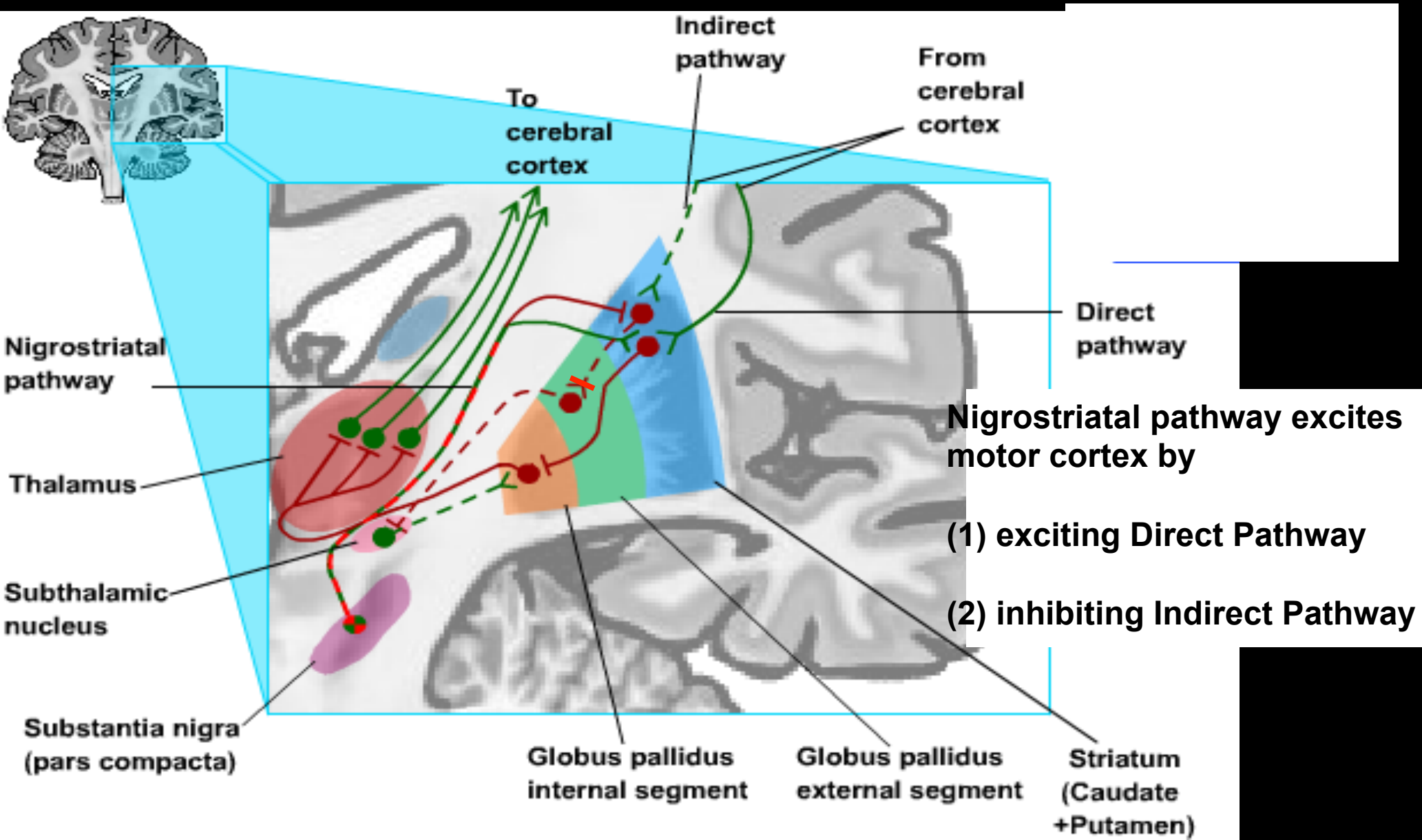
- Complications:

- Stroke/ hemorrhage (2%)
- Infection (4%)
- Hardware complications – leads breaking, electrode malfunction, stimulator failure, battery failure

MRI of electrode placement



Dopaminergic Input from Substantia Nigra



Deep brain stimulation for movement disorders

- Post-surgery: Programming: pulse width, rate (135 – 185 Hz), amplitude
- Don't really understand how it works

DBS and ...

“No neuron is safe from a neurosurgeon”

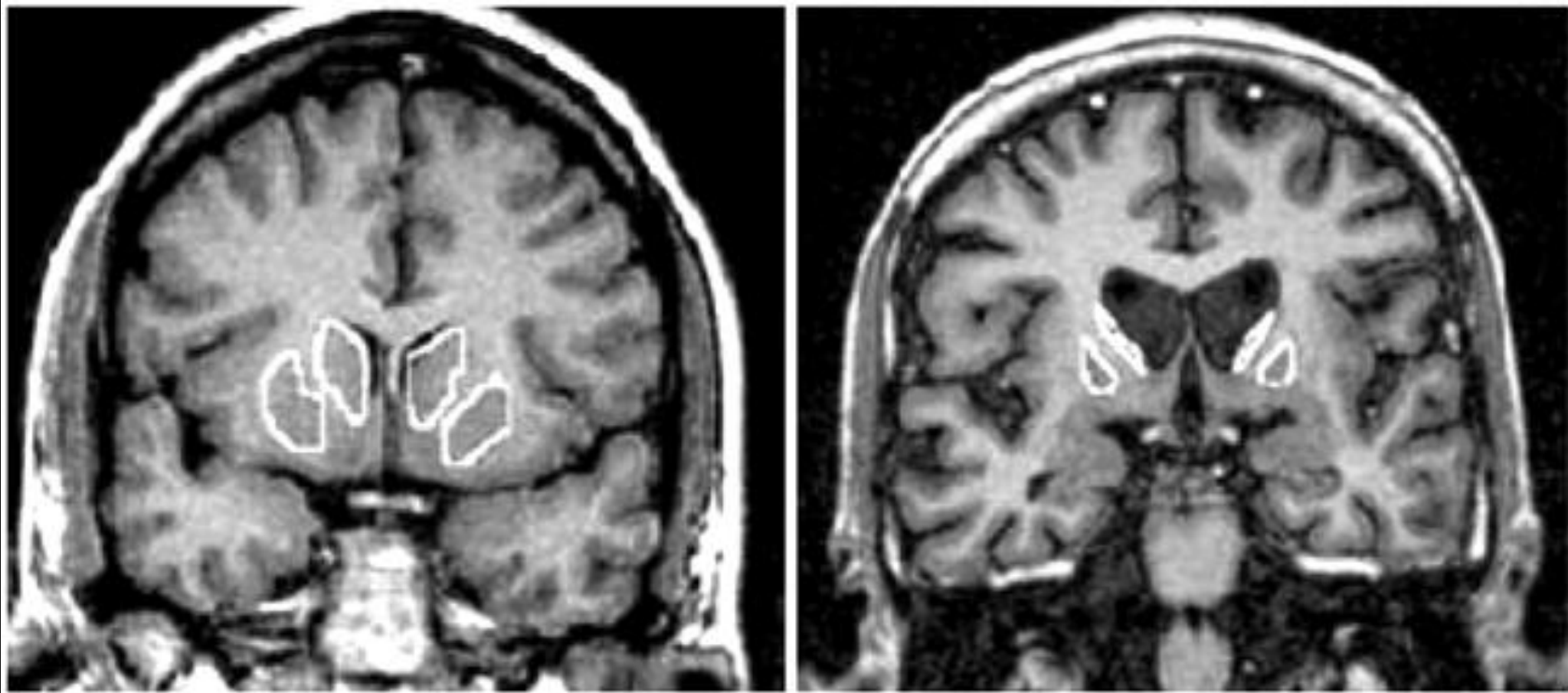
– Andres Lozano, MD,PhD at the 62nd Annual Meeting of the AAN

Huntington's Disease

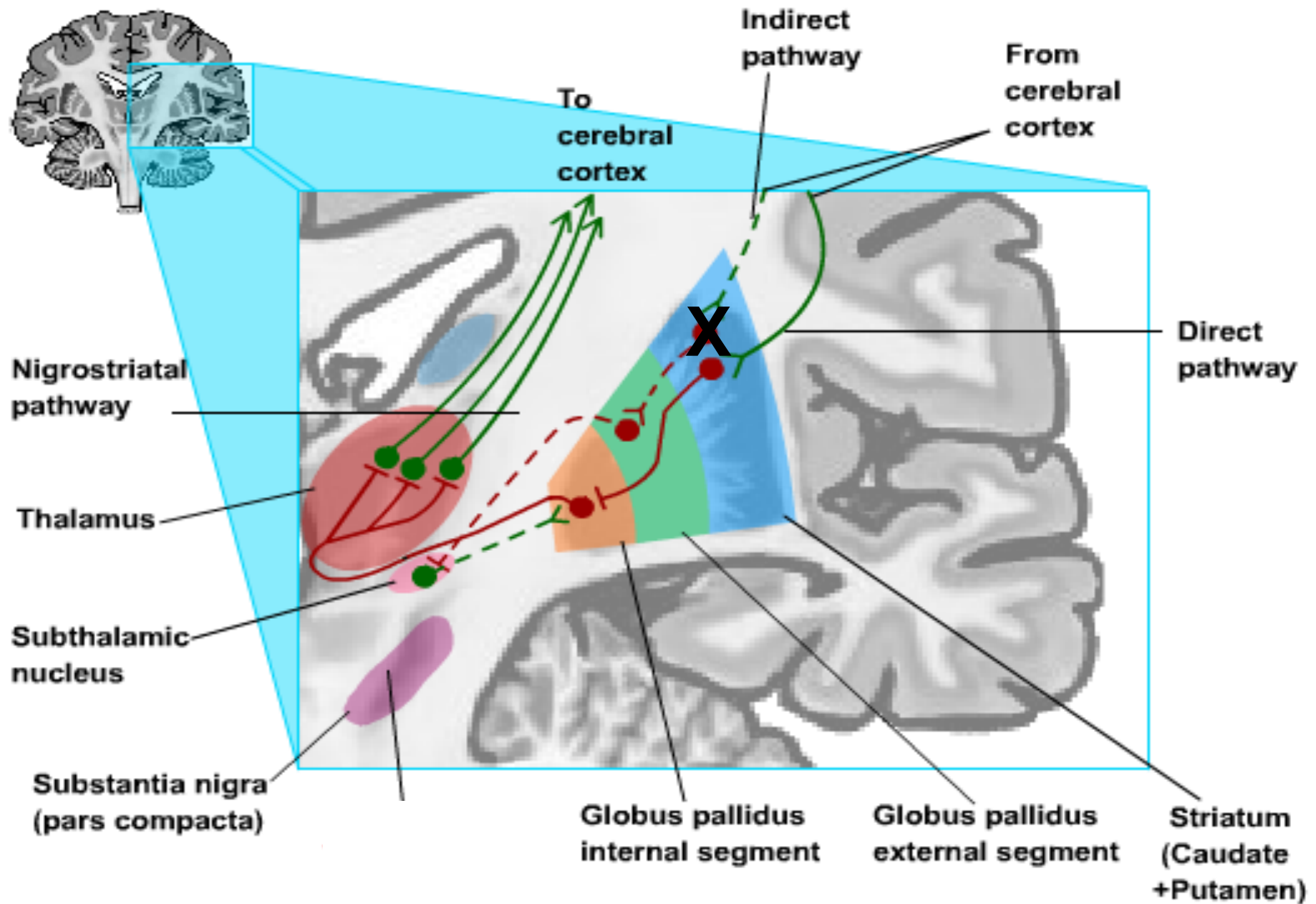
- Genetic disorder caused by an abnormally large number of repeats of nucleotide sequence CAG on chromosome 4
- Autosomal dominant mutation (50% chance of offspring inheriting the mutation and developing the disease)
- Mutation of *huntingtin* gene, causing destruction of indirect pathways neurons of striatum
- Characterized by continuous, choreiform movements of body (esp. hands and face)
- Dementia in advanced cases (reflecting loss of cognitive functions of basal ganglia as well as neocortical degeneration)
- No cure, treatment or prophylaxis

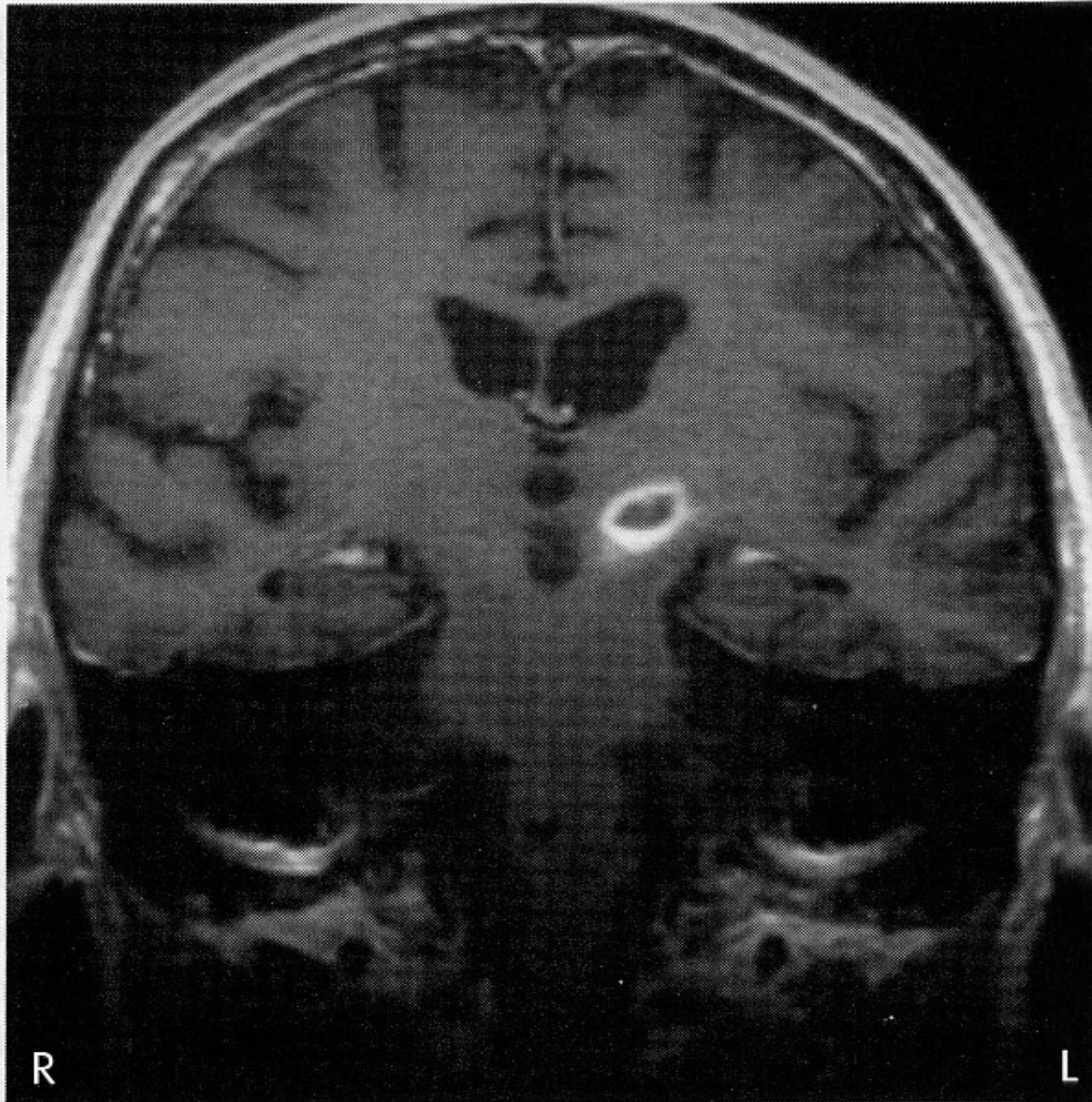


Huntington's Disease



Huntington's Disease

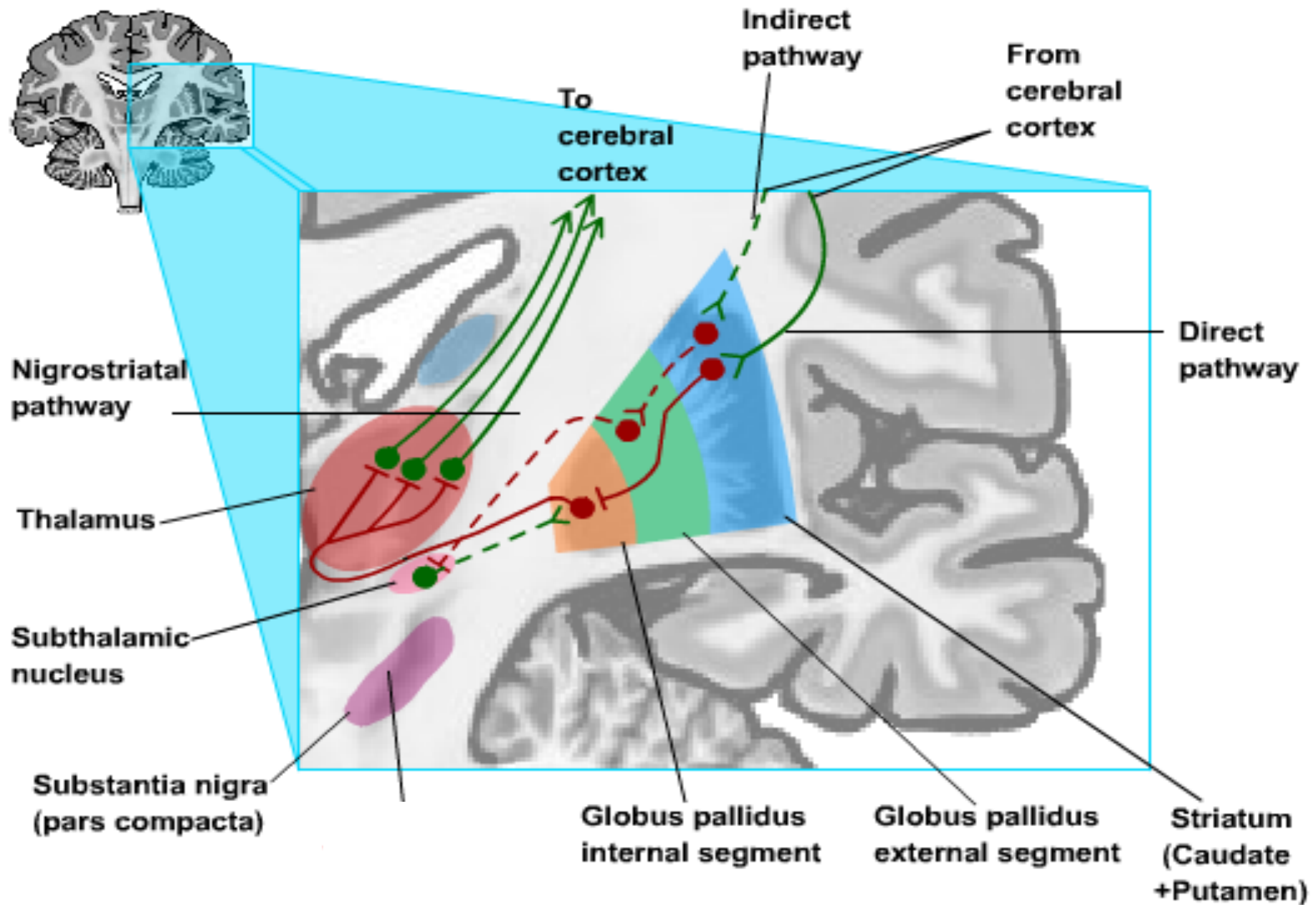


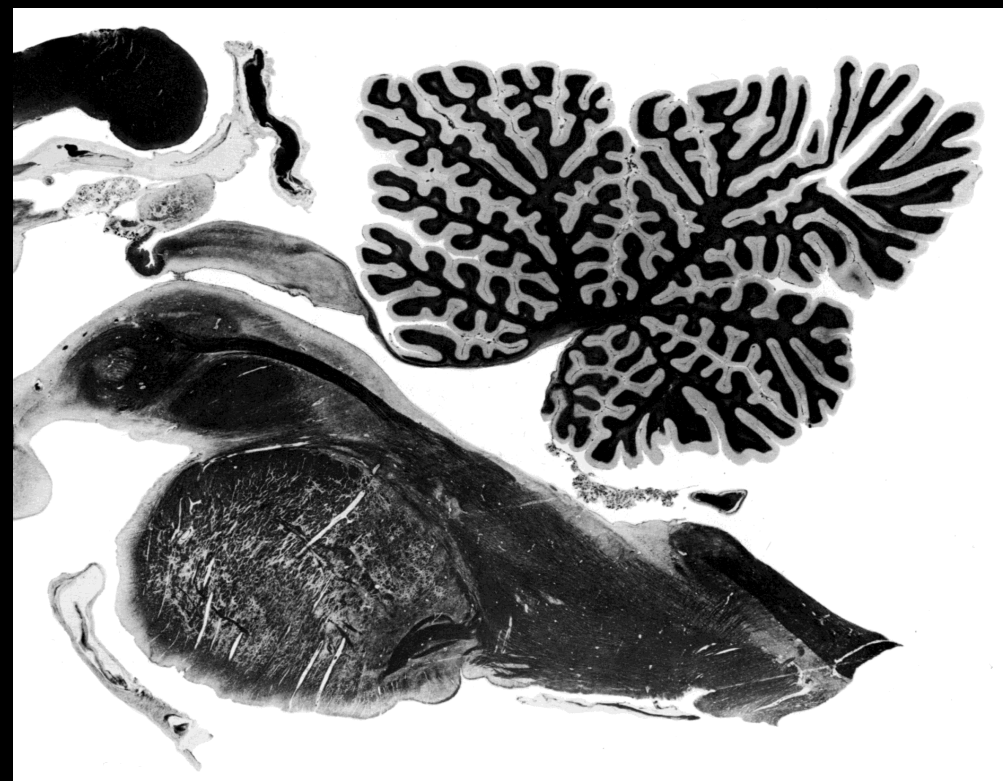


Lesion of the
subthalamic nucleus
produces
hemiballismus

From J. Nolte (2002) *The Human Brain, 5th Edition*

Hemiballismus



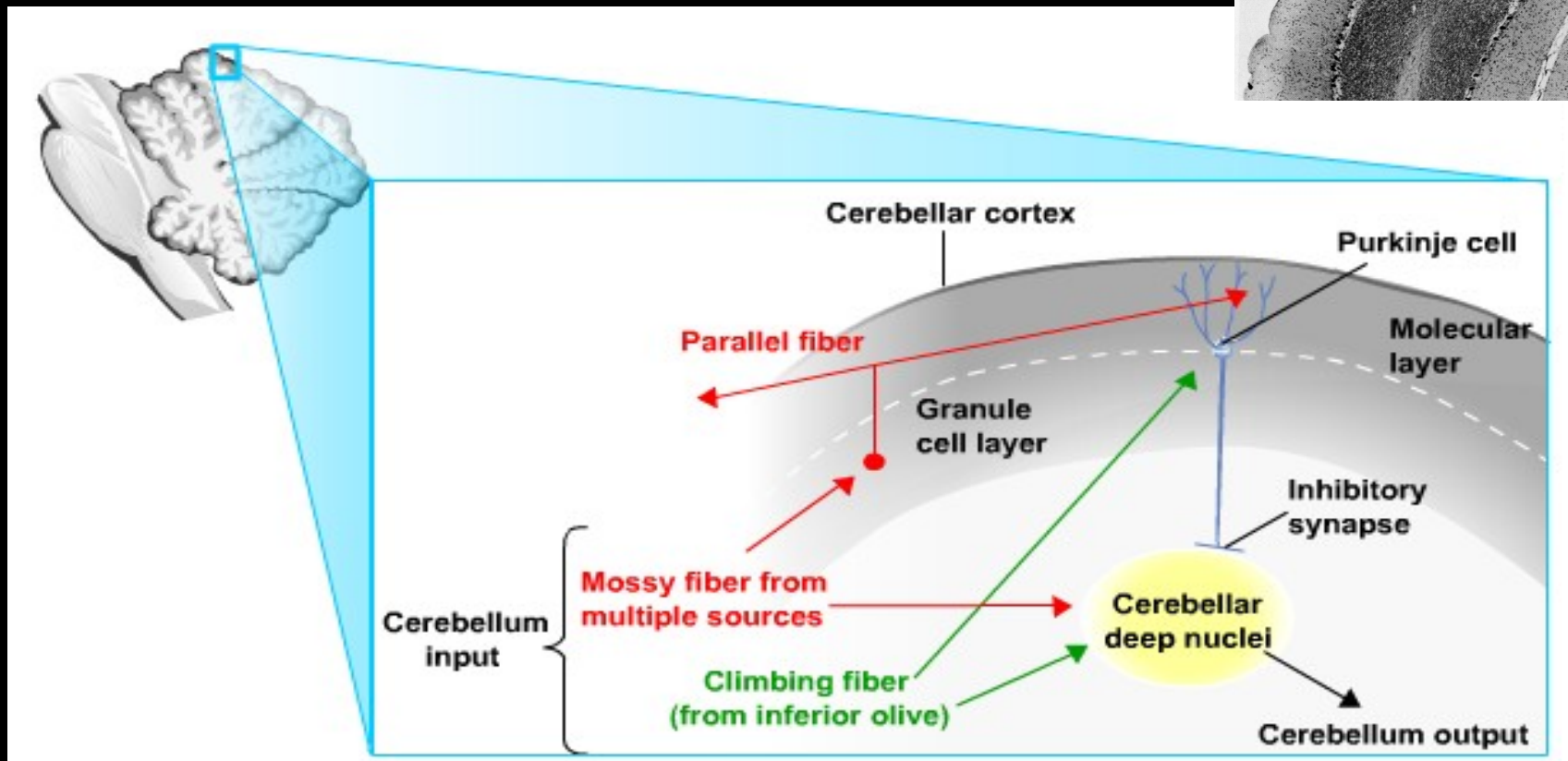
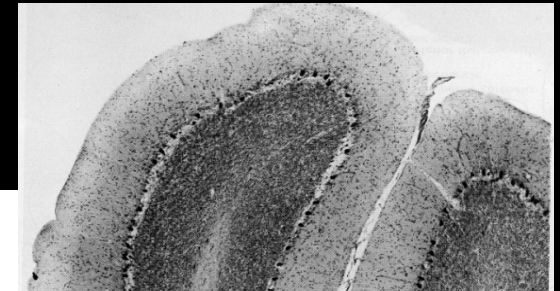


Disorders of the Cerebellum

- Ataxia
 - Disturbance of posture or gait
 - Decomposition of movement
- Dysmetria
- Dysdiadochokinesia
- Scanning speech
- Hypotonia
 - Pendular reflexes
- Tremor (intention tremor)
- Nystagmus
- Delay in initiating movements
- Subtle cognitive deficits

Cerebellum as a feedforward control system

Internal Circuitry of Cerebellum

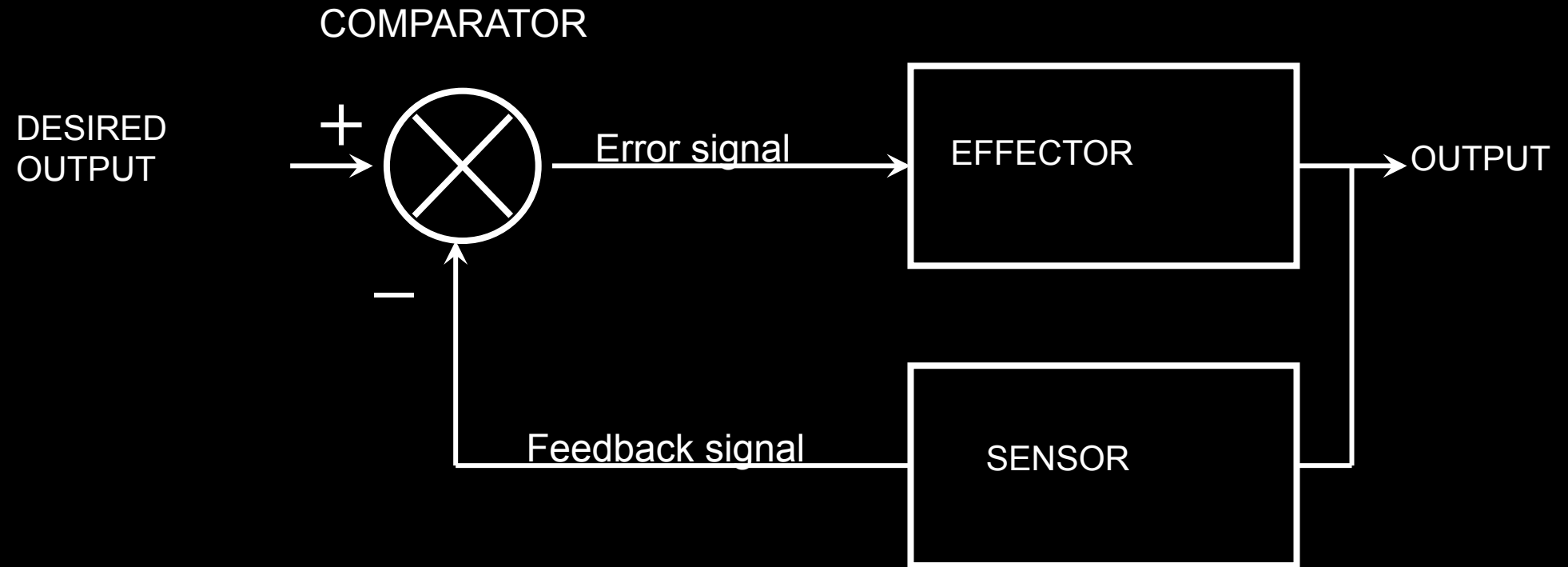


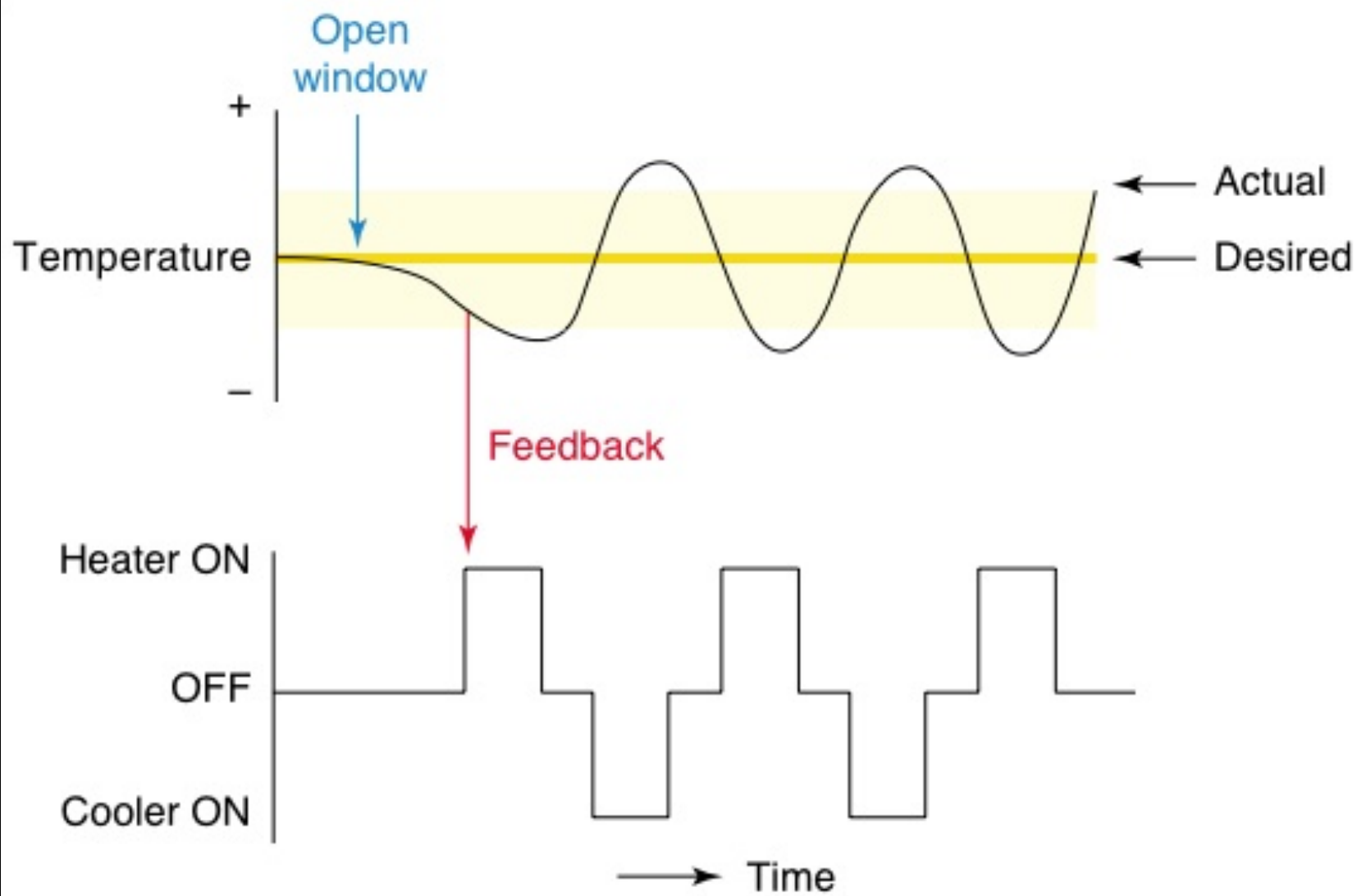
Cerebellum as a Control System

Feedback Controller for Slow movements (e.g., posture)

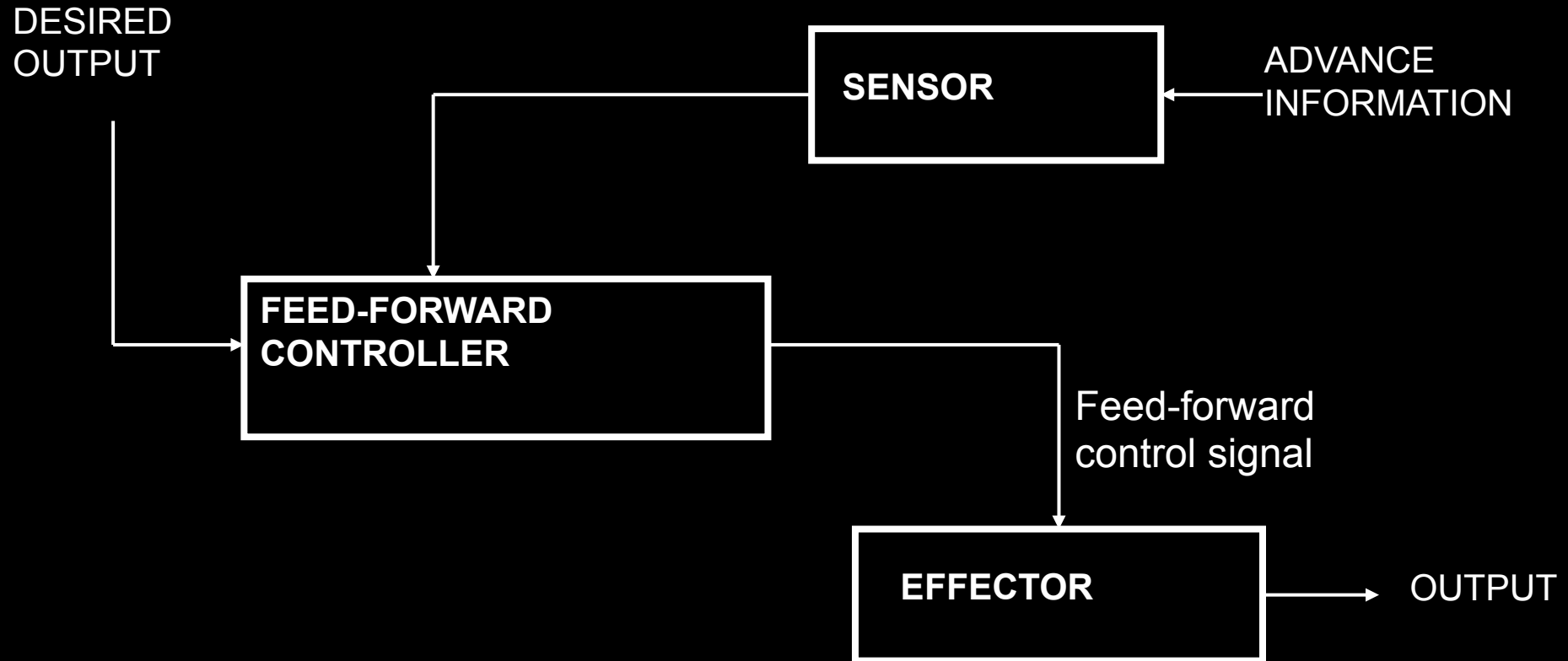
Feedforward Controller for Fast movements (e.g., most voluntary movements)

Feedback control system

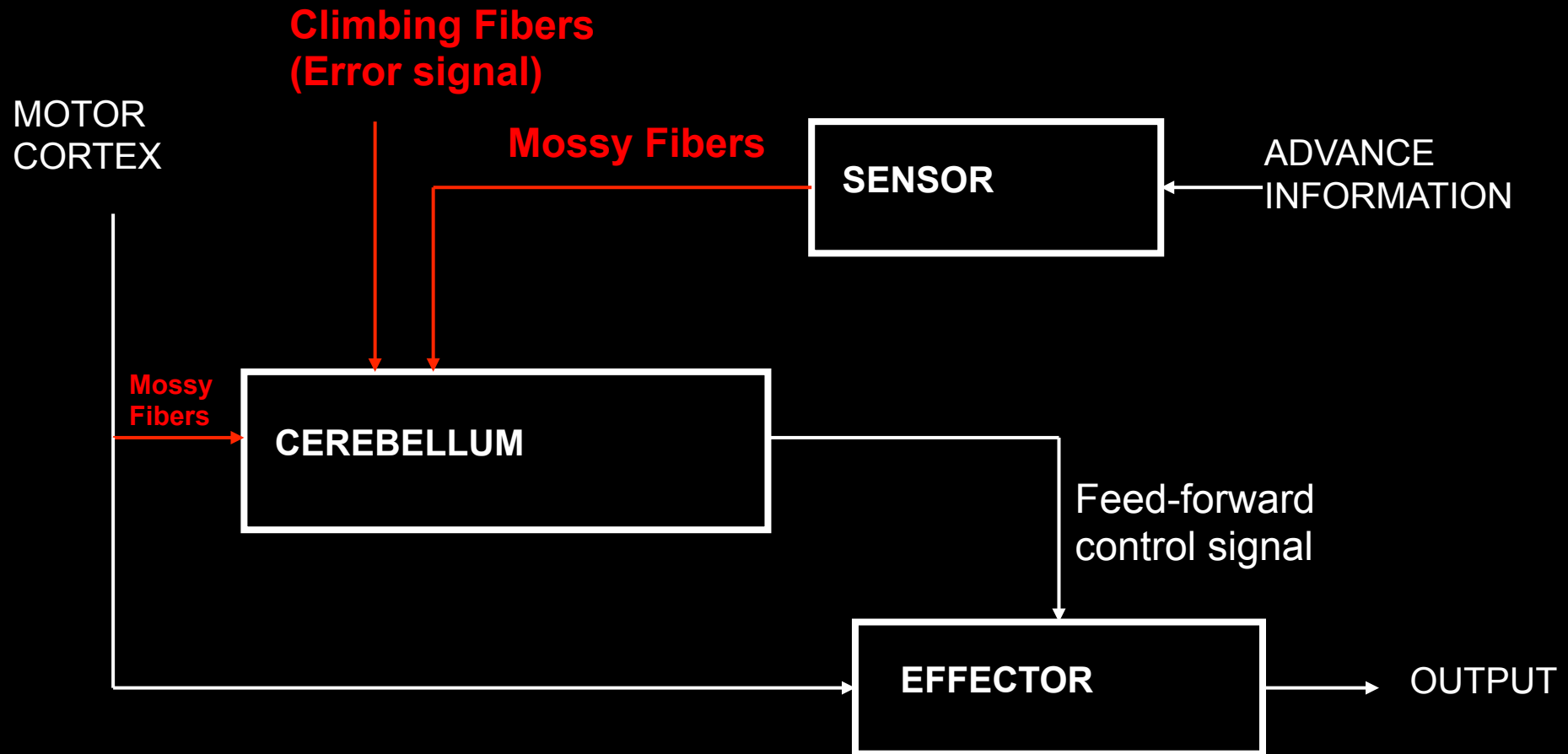




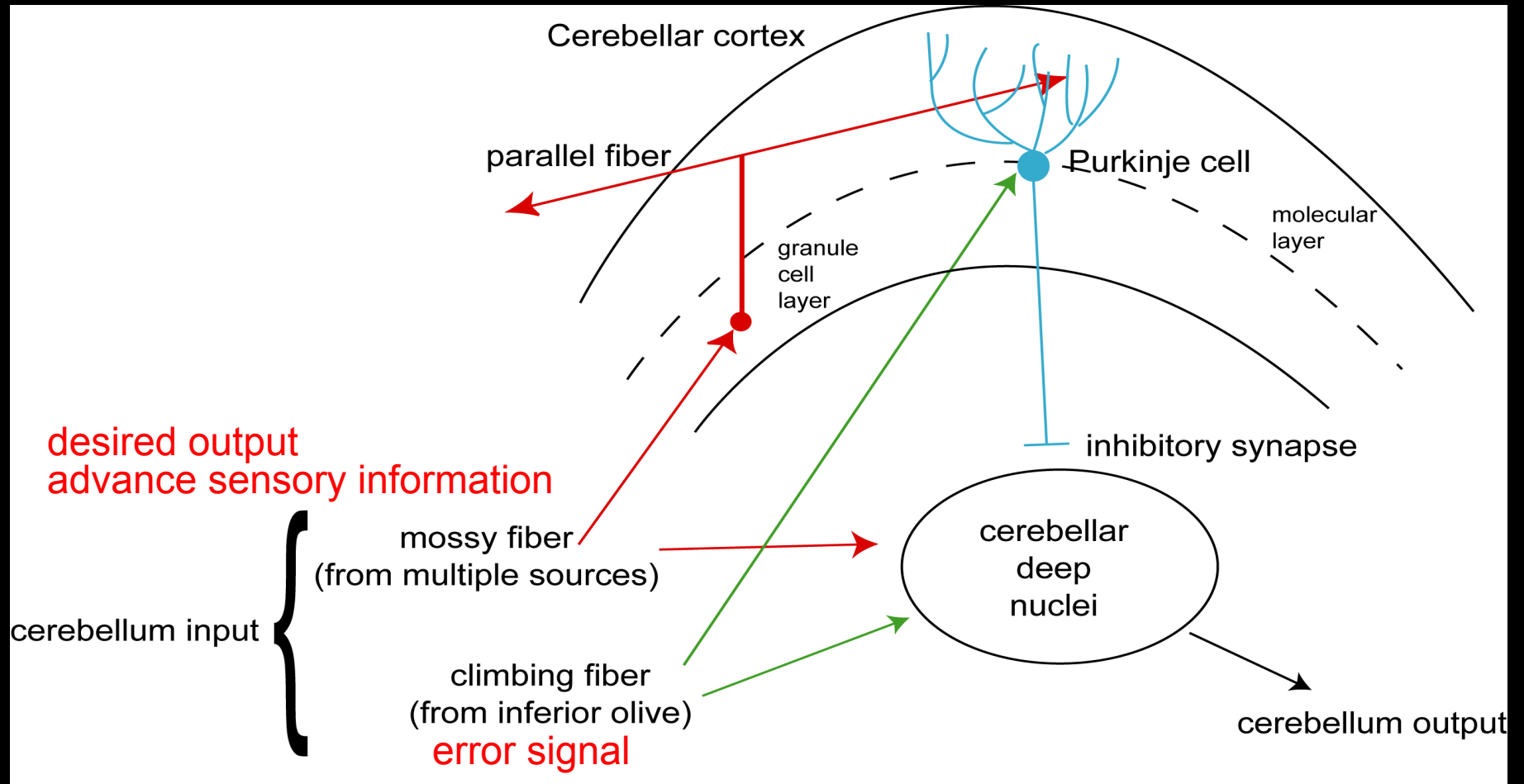
Feedforward control system



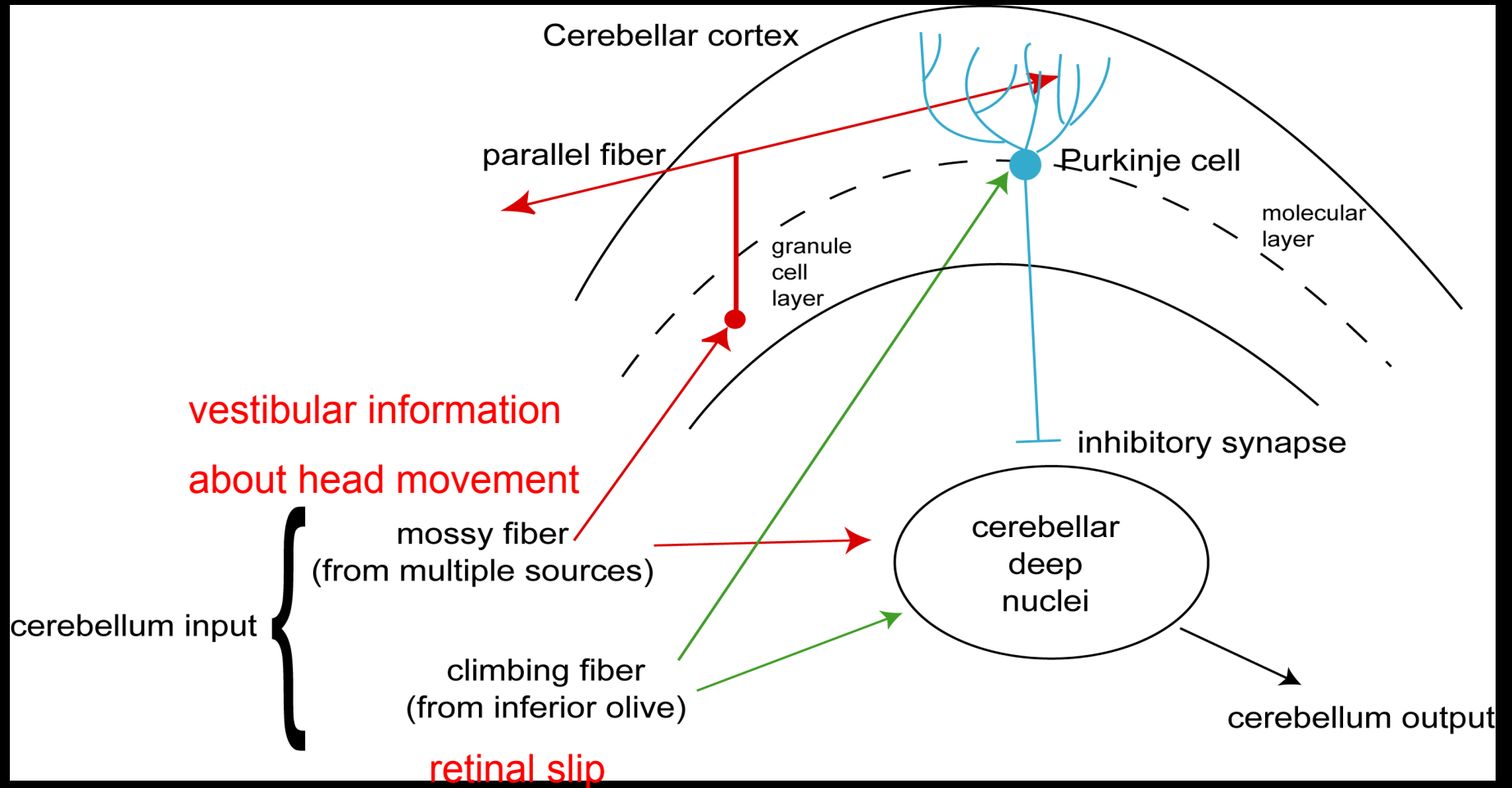
Cerebellum as a feedforward control system



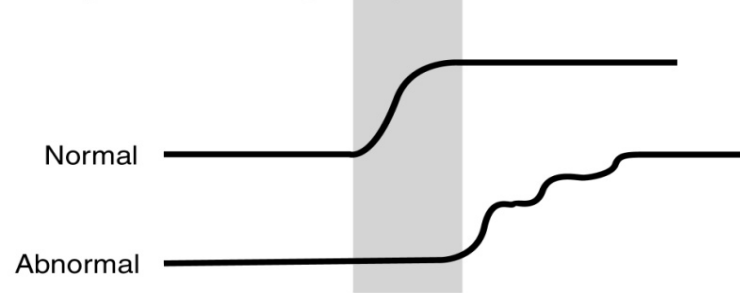
Internal Circuitry of Cerebellum



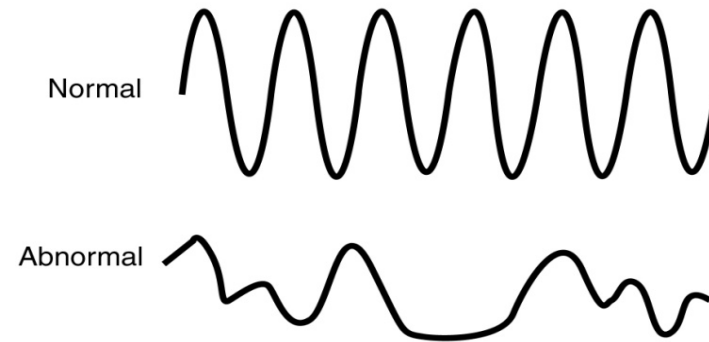
VOR and feedforward control



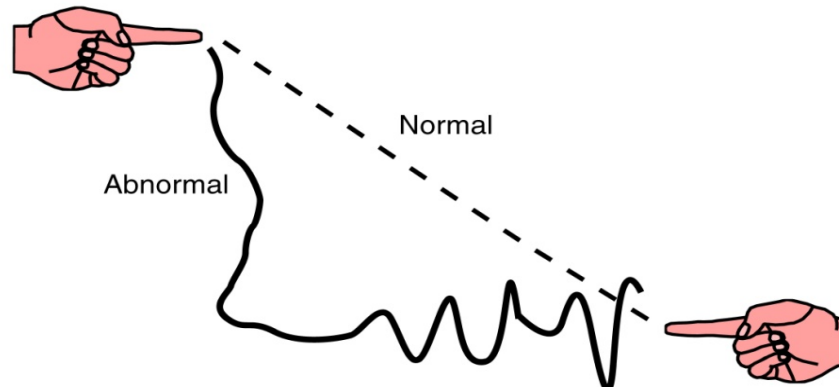
Delay in initiating responses



Dysdiadochokinesia



Decomposition of movement / intention tremor



Necessary Components of Proper Motor Control

- Volition
- Coordination of Signals to many muscle groups
- Proprioception
- Postural adjustments
- Sensory feedback
- Compensation for body and muscles
- Unconscious processing
- Adaptability